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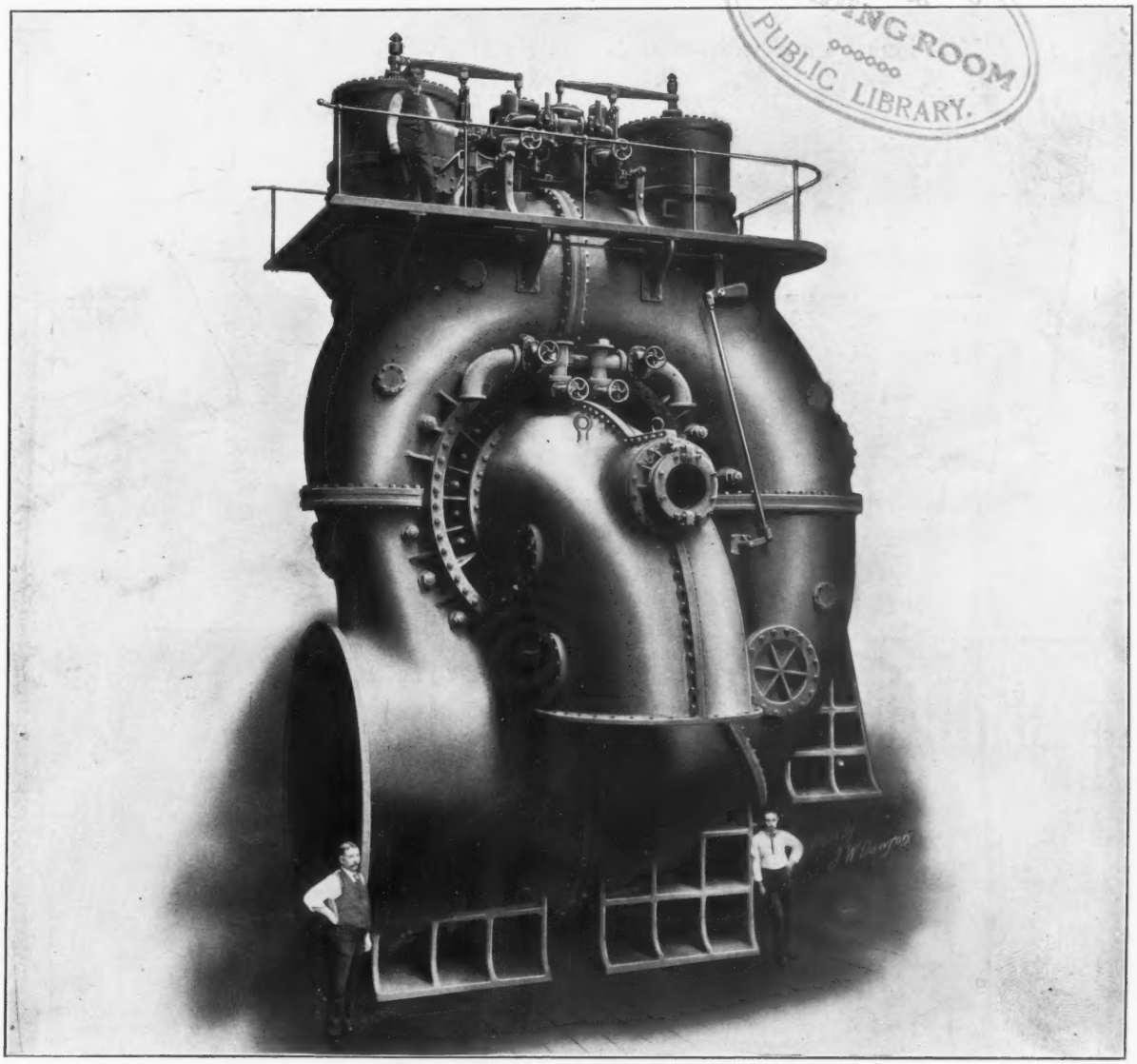

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The
Practical Engineer

A monthly journal, devoted to the economical generation and utilization of power
and to the interests of stationary engineers

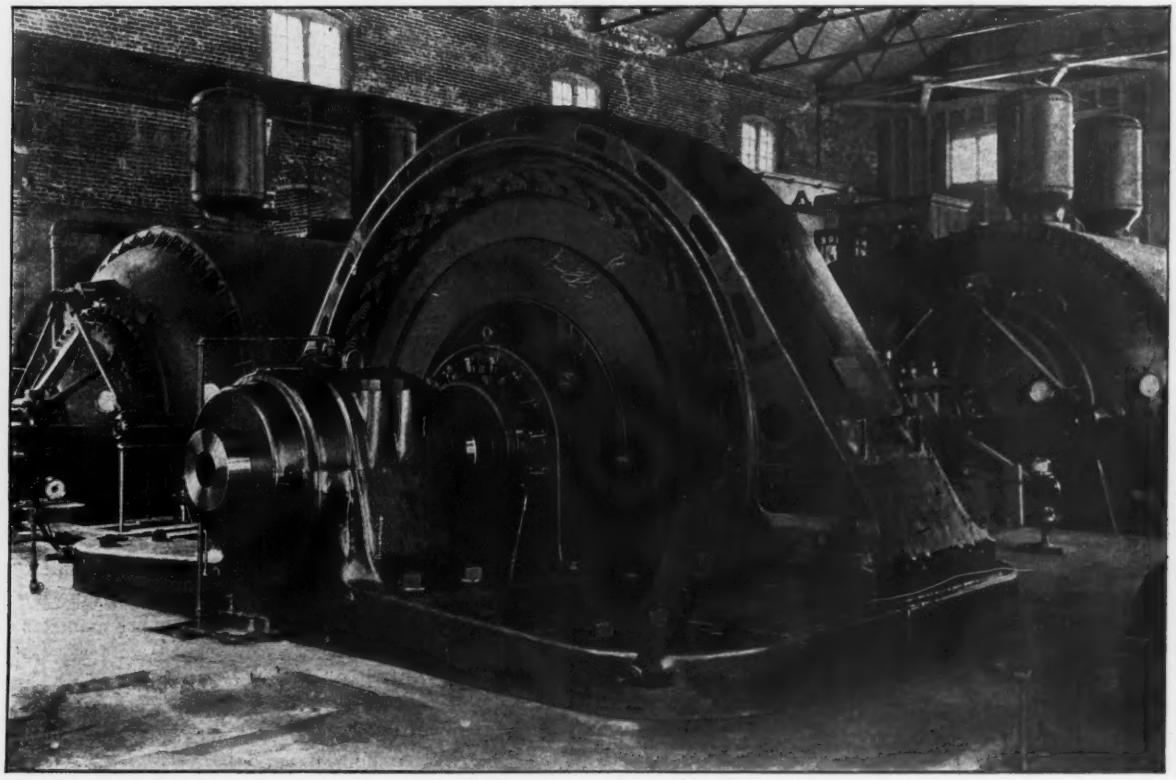
VOL. VIII PHILADELPHIA, JANUARY, 1905. No. 12.

HYDRAULIC PLANT AT SHAWINIGAN FALLS

Canadian Power Plant which Contains the Largest Turbine Ever Built

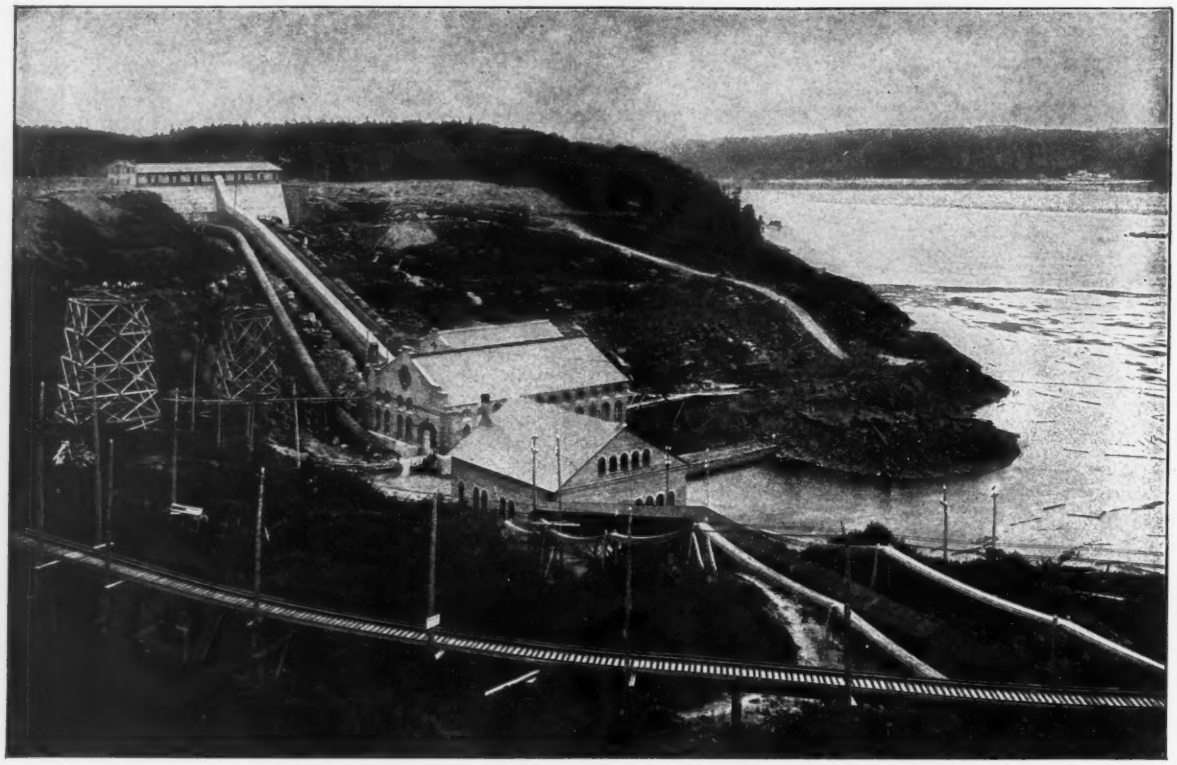
There has been no growth in the development of the power resources of any section of a country which can equal that which has occurred on the St. Maurice River in Canada, at a distance of 84 miles from Montreal. That this growth has been rapid can best be shown by the fact that while, five years ago, the only means of access to the point where the power house now stands was by means of a canoe, to-day there is not only the power house but a thriving town with many different industries at the spot where the wilderness then reigned supreme.

The reason for this rapid growth has been the demand for cheap power and the first engineers, ever eager to grasp nature's resources, saw at Shawinigan Falls a site that was rich in power possibilities. The St. Maurice River at this point runs in a channel about 1000 feet in length, 600 feet in width, and 20 feet in depth, leading from an upper lake right up to



Interior of the Shawinigan Falls Power House.

the brink of the falls, which gives an actual working head of 130 feet on the water wheels, from which it has been figured out that 100,000 horse power is available, the river through the channel running at the rate of about 3½ miles an hour. The St. Maurice River rises in Northern Canada about 300 miles north of the St. Lawrence River, into which it flows. the first two installed are without gates on the pressure side, butterfly valves in the draught tubes taking the place of the usual gates. Lombard governors govern these two wheels and have their operating cylinder fixed to the face of the case. The third turbine is similar to the other two except that it is installed with the movable guide type of gate.



The Power House of the Shawinigan Water & Power Company showing Head Race 125 feet above the Power House.

It drains an area of about 18,000 square miles and at the site of the power house gives a low water flow of about 10,000 cubic feet per second.

Besides supplying water to the electrical power plant, the falls supply 10,000 horse power to the Pittsburg Reduction Co., who have installed their own water-wheels and direct current generators for use in the reduction process of manufacturing aluminium. Each of the wheels in this plant consists of a pair of inward flow turbines which take water at the bottom of the case and discharge it through quarter turns and draught tubes at each end of the case. A 300-volt direct current from the generators is carried directly to the reduction room over aluminium rods ⅜-inch in diameter.

The Shawinigan power plant is now developing 18,000 horse power and when the turbine, shown on front cover of this issue, is in operation, 28,500 horse power will be developed. The first three 6000 horse power units are of the horizontal shaft type running at 180 revolutions per minute directly connecting to a revolving field type of generator, generating current at 2200 volts. The turbines take water at the sides of the cases and discharge through single draught tubes. Two of them were built by Swiss manufacturers and the third by I. P. Morris & Co., of Philadelphia. They are of the Francis type,

The new turbine of 10,500 horse power about to be installed in the Shawinigan plant is the largest turbine ever built and was completed in the short space of four months by I. P. Morris & Co., of Philadelphia. It is also of the horizontal type, the water entering at the lowest part of the turbine and flowing out through two draft tubes, one on each side. The weight of this monster water wheel is 182 tons, the shaft alone weighing 10 tons and the bronze runner 5 tons. It is 30 feet from base to top and 32 feet 2½ inches wide over all, which is the length of the shaft. The shaft is built of solid forged steel, 22 inches diameter in the middle, tapering down to 10 inches diameter on one end and 16 inches diameter on the other, the distance between bearings being 27 feet.

So large was this turbine that when shipment was made it required five flat cars and one box car to transport it and a special route had to be selected where bridges were high enough to allow the hugh parts to pass under. The water which is consumed hourly by the big wheel would form a fair sized river. The intake is 10 feet in diameter and the quantity of water going through the turbine when developing full power is 395,000 gallons a minute. The speed of the wheel is 180 revolutions per minute with a head of water acting on the turbine of 125 to 135 feet. Some enterprising person has

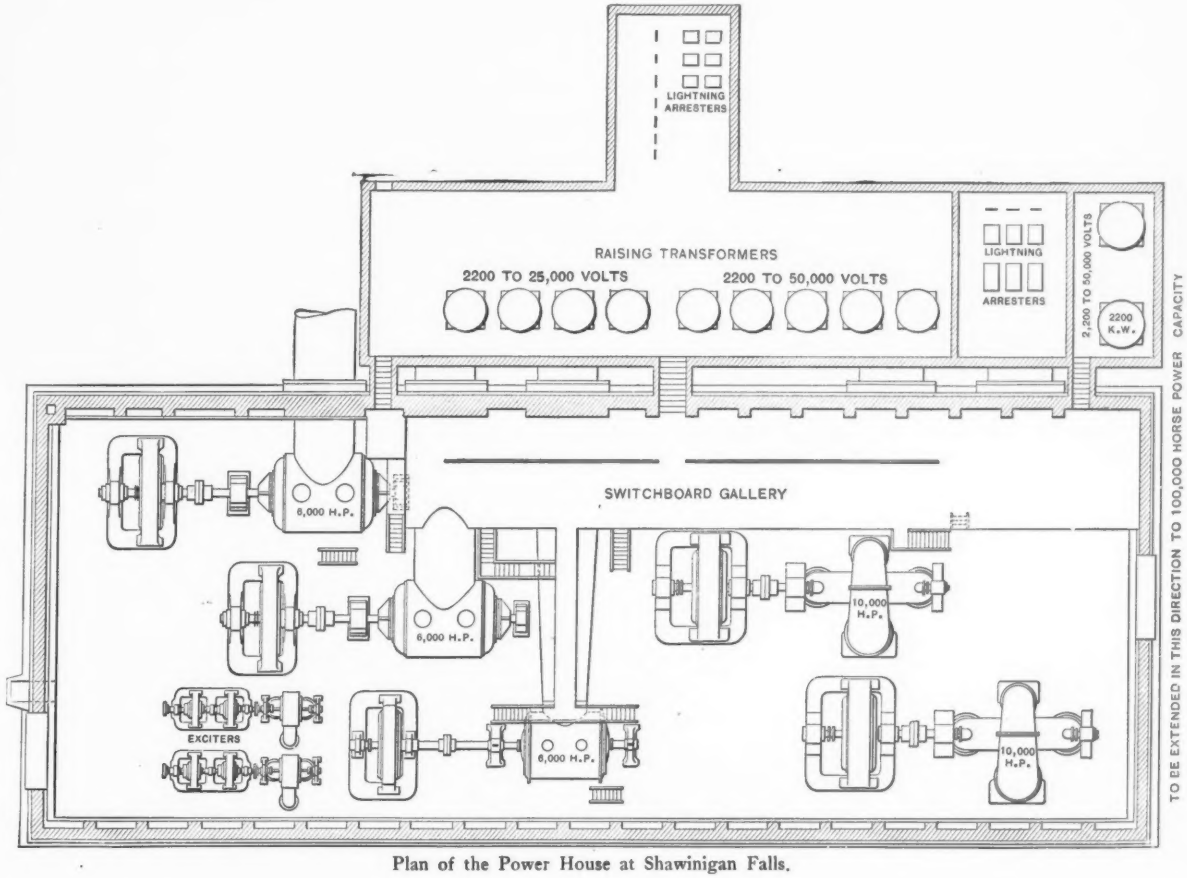
figured out that the water which the turbine uses is equivalent to a river 88 feet wide, 10 feet deep, with a constant flow of 60 feet per minute.

The electric current generated by the turbines was originally intended to be used for local industries and not for long distance transmission but the demand upon it from Montreal, 84 miles away, became so great that over 6000 horse power is now being delivered there. The three generators installed with the three 6000 horse power turbines are each of 3750 kilowatt capacity with quarter phase 2200 volt and 30 cycles current. As Montreal service requires 60 cycles, the current is sent at 30 cycles and is converted to 60 cycles in Montreal by means of synchronous motor-generators.

The current after leaving the generators goes to the transformer house in which are located the step-up transformers for the local power distribution and the long distance transmission. The transformers are of the oil insulated type and the rated capacity of each transformer is 1110 kilowatts. The transformers are arranged for transforming from 2200 volts quarter phase to 50,000 volts, three phase. The transformers are water cooled, the cooling water circulating through spiral brass tubes immersed in the oil near the top of the case. The transformer cases are made of boiler iron and are designed so as to make use of a device intended as a protection against fire in the transformer oil.

From the high tension terminals of the transformer, the current passes to high tension bus-bars through long-break switches, static interrupters and lightning arresters. It then passes on to the line which consists of three aluminium cables, each composed of No. 7 aluminium wires. The total drop in the transmission line when 8000 horse power is delivered to Montreal is about 18 per cent. The line cables are arranged in an equilateral triangle, the distance between centres of the cables being 60 inches. One of the cables is carried on the pole and the other two are carried on the arm. The insulators are made of porcelain and cement and were designed to stand a voltage of 100,000 volts. The poles are cedar and are set 100 feet apart, the cross-arms are of southern pine, treated by dipping in a preserving mixture, and the pins are hickory, treated by boiling in stearic acid.

The transmission line enters the terminal station in a similar manner to the way it leaves the step-up transformers and after entering the step-down transformer room it passes through lightning arresters and static interrupters and thence to the step-down transformers. The step-down transformers are similar to the step-up transformers, except that their capacity is 1000 kilowatts instead of 1100 kilowatts and they are wound for transforming from 44,000 to 2400 volts. From the step-down transformers the current goes to the synchronous frequency changers and from them at 60 cycles to the distributing bus-bars. The frequency changing sets have a capacity of 800 kilowatts at a power factor of 75 per cent. and consist of a three phase 30-cycle 2400 volt synchronous motor, direct connected to a three phase 2400-volt 60 cycle generator.



Plan of the Power House at Shawinigan Falls.

The growth of Shawinigan Falls has been very rapid since the beginning of operations a few years ago. Besides the

plant for making aluminium, there is a pulp mill, a plant for the manufacture of calcium carbide and another for the manufacture of ferro-manganese, and as considerable flax is grown in the vicinity, a linen mill is about to be built there. Shawinigan Falls is now a city of 3000 inhabitants.

The first work of the development of the Falls was the building of a railroad to it which was commenced in May, 1899. Work was begun on the plant about June 1, 1902, and the transmission of the power to Montreal began on February 3, 1903. So great was the demand for power upon it that in May 19, 1904, the large 10,500 horse power turbine was ordered, which was completed in the rush time of four months by I. P. Morris & Co.

Armature Windings For Direct Current Machines

Ring, Drum, Lap and Wave Style of Closed-coil Windings

The electro-motive force of a dynamo, or the voltage which it gives out, depends upon three factors: the strength of the field, the number of conductors on the armature, and the speed of the armature. It is a well-known fact that strengthening the field of a dynamo increases its voltage and increasing the speed also increases the voltage, but for any constant potential machine, the number of conductors on the armature which are active in producing electro-motive force always remain constant.

The designer of a machine, in taking these things into consideration, fixes upon the strength of the field and the speed of the machine, from which he derives the number of conductors on the armature required; or, he assumes the number of armature conductors, and calculates the field and speed required to produce a certain voltage; but, whatever the

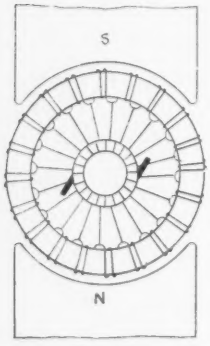


Fig. 1.

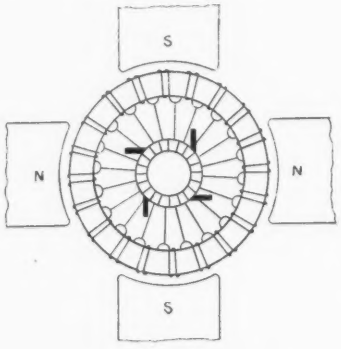


Fig. 2.

method, the result is, that a large number of conductors must be placed upon the armature in such a way that the proper electro-motive force is generated, the size of the wire must permit sufficient current to pass through it without overheating, and proper connections must be made to the commutator, etc.

The principal difficulty experienced by the early students in electricity was in understanding the armature winding and a man who in those days could perform the task of successfully winding an armature so that it was in balance and did not short circuit or overheat, or, who could finish the maze of wires bristling from the armature into a neat series of connections to the proper commutator bars and get the desired voltage, was looked upon as a wizard. A careful study of the subject reveals that certain objects must be attained in any winding and a systematic method must be adopted before even the simplest can be understood.

It is usual in the discussion of this subject to divide the different types of armature windings into the "closed-coil" and "open-coil" types, ring and drum types and the kind of windings into lap and wave windings. When the inductors and

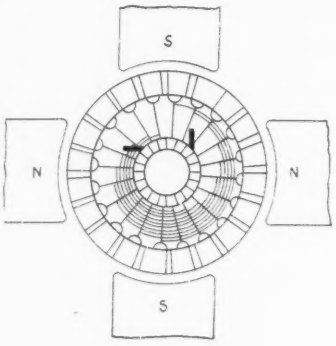


Fig. 3.

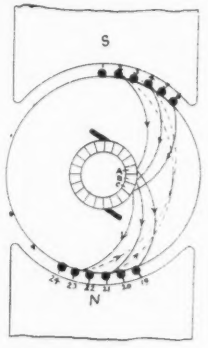


Fig. 4.

commutator segments are not all electrically connected with each other, the winding is called an open-coil winding. Open-coil windings are used chiefly on arc lighting dynamos. Closed-coil windings are more generally used for incandescent lighting and power purposes. In the case of closed-coil windings, all the inductors on the armature are engaged all the time in adding electro-motive force to the circuit, except when short circuited by the brushes at commutation, and while there are

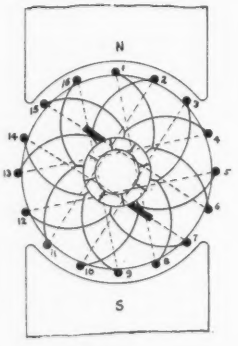


Fig. 5.

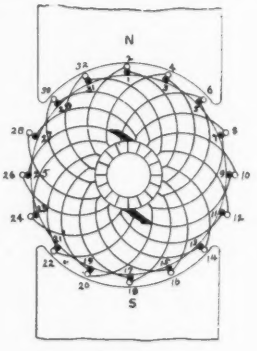


Fig. 6.

many forms of closed-coil windings the inductors in all of them form one or more endless circuits around the armature core. The two principal types of closed-coil armatures are the ring armature and the drum armature.

The ring armature consists of an annular ring around which the armature conductors are wound in a continuous

spiral or number of spirals which are tapped off at equal intervals to the commutator bars. Fig. 1 shows a simple, bipolar, two circuit ring winding. The magnetic lines of the field pass from the north pole to the south pole. As the armature rotates the conductors on the exterior surface cut across the magnetic lines twice in each revolution and since

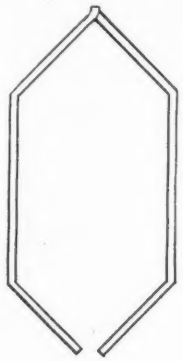


Fig. 7.

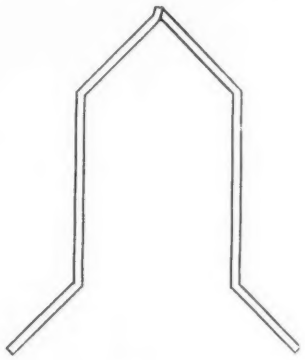


Fig. 8.

there is no flux on the inside of the ring the conductors on the inside merely serve to connect the outside conductors in series.

A four pole ring winding is shown in Fig. 2. The winding is similar to that shown in Fig. 1, but the number of brushes is doubled, and the number of coils should be a multiple of the number of poles. There are two negative and two positive brushes, the brushes of the same polarity being connected together. There are other types of ring windings which are arranged to give different results. For instance: if in Fig. 2, two brushes were to be used instead of four brushes, the end connections would be connected together as shown in Fig. 3. For machines with a larger number of poles there would be a corresponding increase in the number of circuits in the armature. There is also a variety of end connections which can be made, but since ring armatures are very much less used

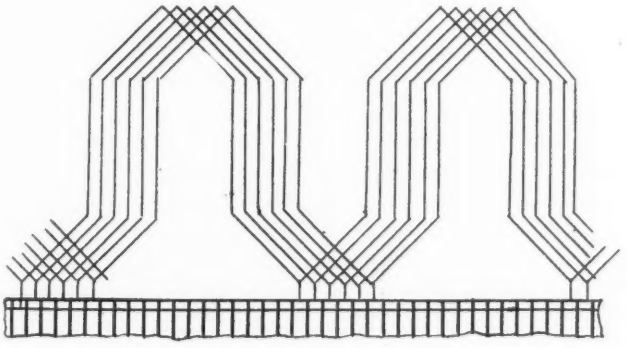


Fig. 9.

than drum, they would perhaps seldom be found in practice.

Windings for drum armatures are very complicated and an attempt to show by a diagram a complex winding would only result in confusion. They differ from ring windings inasmuch as all the conductors lie on the outside surface of the core and hence all the wire is active in producing electro-motive force except the end connections, while in a ring armature a large amount of wire is utilized in merely serving as conductors on the inside of the ring. In a ring armature, the adjacent coils are in series with each other, while in a drum armature, the connections must be so made that each conductor must join another conductor in such a manner that the electromotive force is cumulative. The return coil always lies under a pole of opposite polarity, so that it involves a series of end connections which entirely cover the end of the armature core.

The end view of a drum winding is shown in Fig. 4. The coils are so connected that the current passes from bar to bar. In the figure, but two complete turns are shown, but all the other coils are connected similarly. Coil No. 2, after traversing longitudinally along the south pole, is brought across the end to commutator bar marked A, from whence it goes to coil No. 19 on the other side of the armature, which traverses longitudinally along the north pole and across the back of the armature indicated by the dotted line, and back along wire marked No. 4 to commutator bar marked B, to which wire No. 21 is also attached, and so on all around the armature. Fig. 5 represents a completed winding of a simple drum armature where there are half as many commutator bars as there are slots in the armature or as many bars as there are complete coils. Fig. 6 represents a winding two layers deep for a single pole machine. As the number of poles increase and the number of conductors on the armature multiply, the winding becomes still more intricate, but still the same law applies of

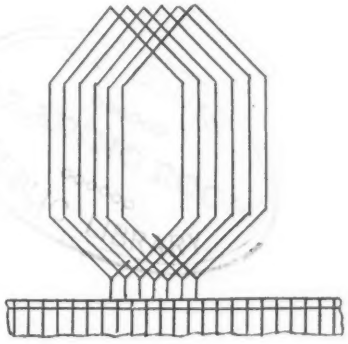


Fig. 10.

joining a conductor under one pole to a conductor under another pole of reversed polarity.

The open-coil winding is similar to the closed-coil with the exception that each coil is alternately cut in and out of circuit and is not connected to any other coil by end connections. The opposite coils are connected in series. This style of armature winding is used chiefly for arc light machines. The electromotive force is varied by shifting the brushes, which cut coils in and out of circuit, so as to maintain an even current on the line.

The coils are wound on drum armatures in one of two ways, known as the lap winding or wave winding. The winding of an armature is very much simplified these days by the formation of coils, shown in Fig. 7 and 8. Fig. 7 represents a coil for a lap winding and Fig. 8 represents a coil for a wave winding. For small machines, wire is used in their construction, but for large size machines they are formed of flat rods. They are insulated carefully and are formed by machinery so that they will exactly fall in place when placed on armature. The different forms of wipdings can be shown in a different manner from those shown in Figs. 3, 4, 5 and 6. In those figures the windings are shown as they would appear on the armature looking at them on the end. A far easier way is to

look at them at right angles to the plane of the coils and assume the circumference of the armature to be one flat plane. In this manner, the conductors on the armature and the connections to the commutator can be shown more clearly. Fig. 9 represents a wave winding drawn according to that method. In the wave winding, the coil goes across the armature and back without crossing itself, while in the lap winding, the wire doubles back on itself at every turn. Fig. 10 represents a developed lap winding.

Whatever the style of drum winding, great care must be exercised both in regard to insulating and fastening the coils, especially the end connections. They are usually insulated with mica where the best of insulation is needed, but on account of its cost and the difficulty of manipulating it, canvas, oiled paper and vulcanized fibre are among the insulations used. Japan and shellac are used liberally, especially when canvas is used. All armature conductors must be banded to prevent their dislodgment under the centrifugal action at high speeds. The wire used for this purpose is generally of hard drawn brass, phosphor-bronze or steel. It is wound over insulating strips forming a band of several turns which are sweated together with solder. With toothed cores, a strip of maple wood is fitted into the recesses and acts like a cover to the slot, which firmly holds the windings in place. The fastening of the ends of the coils to the commutator is usually done by placing the tinned ends of the coil in the commutator slot and sweating them in with solder.

Explosion of a Threshing Engine Boiler.

That Rodney Gumkirk, of Orkners Corners, Michigan, is not the only one who has had trouble with his treshing machine is illustrated by the boiler explosion which is described herewith:

It took place on November 11th last, on a farm about five miles from Elkhart, Indiana. While the threshing outfit was

Path of the Exploded Boiler.

being used for threshing corn fodder, the boiler exploded and, like a gigantic sky-rocket, it was hurled through the air and landed on a fence between 300 and 400 feet away from the spot where it had been anchored by the stay beams attached to its wheels. In its flight it struck a black oak tree about 13 feet from the ground and broke it off at the ground.

The explosion of the boiler caused the death of three persons and injured several others. Two boys who were near the boiler when it exploded were instantly killed. Two men were standing near the tree which the boiler struck and one of them was killed by the front wheels and axle of the flying machine, while the other man was seriously injured. The man

Rear View of the Exploded Boiler.

in charge of the machine was walking toward the engine to start it when the explosion took place. He heard a crash, shut his eyes and when he opened them, the air was filled with dust and steam. He sustained a severe gash in the leg by one of the flying pieces. A third boy who was standing near the machine when the accident happened was badly scalded by the flying water. There were a number of other persons on the premises but besides being shocked they were uninjured.

Pieces of the boiler flew in all directions, and the blast from the rear hurled a cultivator from a spot near it to a point on the opposite side of the road fully 100 feet away, where it landed a complete wreck. One fragment struck the barn 75 feet away and burst a hole through its side. The back end of the boiler and the fire-box were blown out and only the empty shell with engine attached remained where it fell, the detachable portions having been scattered in all directions. Window panes in a residence 1¼ miles to the north were shattered by the concussion and the sound of the explosion carried for several miles.

The cause of the explosion is unknown to any of the survivors. The boiler is said to have been in use many years. It was an 8 horse power engine and 10 horse power boiler. The accompanying views show the course of the exploded boiler and the rear of the exploded boiler after it landed against the fence.

Air Receivers.

An air receiver forms an important part of an air compressing plant. It should be placed at a distance not greater than fifty feet from the compressor. It serves a useful purpose by receiving the air in pulsations from the compressor, and delivering it in an even, steady flow. The air as it comes from the compressor also contains more or less moisture which collects in the receiver and may be drawn off by means of the drain-cocks which are provided with each receiver.

PIPING FOR STEAM HEATING SYSTEMS

One Pipe, Two Pipe, Back Pressure and Vacuum Systems of Heating

Whatever the purpose for which heat is used, it is transferred from a warmer to a colder body in one of three ways. It is transferred by radiation, convection, or conduction. This is just as true in a steam boiler as in a steam radiator or when a piece of iron is heated.

Radiation, which is one of the three methods by which heat is transferred, is a term which is often misused because it is not understood. When radiant heat passes from a hot body to a colder one, it passes through the intervening medium, such as air, without raising its temperature. The sun gives out heat by radiation, and its rays pass through millions of miles of space before it heats the objects on the earth. Its rays will shine through a window and will warm objects beyond it which have absorbing power without heating the glass itself. The intensity of radiation is inversely as the distance traveled, so that the nearer a cold body is placed to the radiant body, the greater will be the intensity of the heat per square unit.

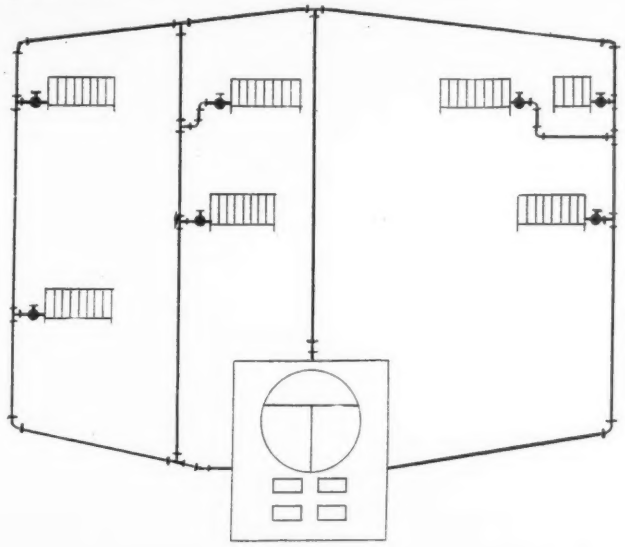


Fig. 1.

The convection of heat is the process of carrying heat from one body to another by means of such substances as water, gas or air. It is by means of convection that heat is carried by steam or water to radiators and also from indirect radiators or hot air furnaces to the bodies of lower temperature with which the warm air comes into contact. To transfer heat by convection, the fluid which conveys the heat must have motion. This is one of the most important factors in the consideration of heating systems as well as in steam boilers or other methods of heating. If the water in a boiler stops circulating, if the steam or water in a heating system be stopped, or if a radiator be put in a room where there is no circulation of air, the efficiency of the heating system is interfered with.

Conduction is probably the most familiar form of heating. If a bar of iron is heated at one end, it will gradually become warmer at the other end by transferring its heat from particle to particle. This is called heating by conduction. Each of the three methods of the transference of heat is illustrated by what goes on in the fire box of a boiler. The incandescent coal gives its heat to the fire side of the heating surfaces by radiation and by convection of the flue gases. This heat is transferred to the water side of the boiler by conduction and is

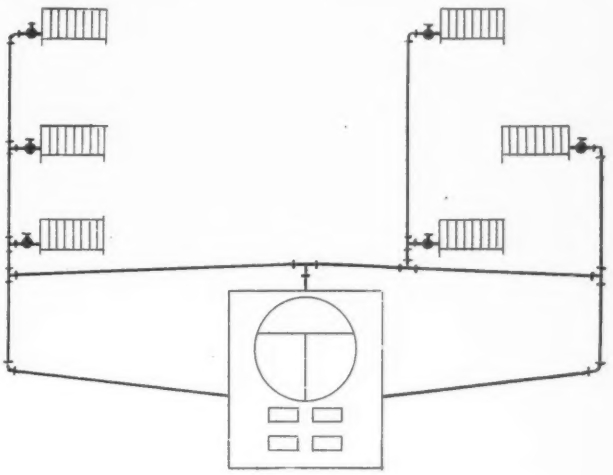


Fig. 2.

there given to the water which carries off the heat by convection.

In all heating systems, there must necessarily be enough heating surface not only to heat the room but also to heat the changing air which is necessary for ventilation. The air in a room is heated principally by convection. If the heating is

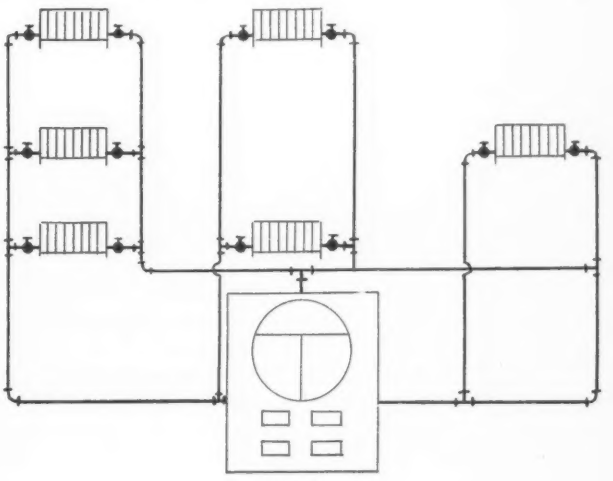


Fig. 3.

done indirectly, the air strikes the heated surfaces before it enters the room, but if direct systems are employed, the air in the room circulates and the cold air, striking the warm surfaces, becomes warm and rises, and other air takes its place.

The three principal systems in use to-day, outside the stove

which is placed directly in the room to be heated, are hot air, steam, and hot water. A large number of dwellings and small buildings are heated by hot air, but all large buildings which have a steam plant use steam for heating although many dwellings and buildings, such as green houses, use hot water system of heating. Disregarding other considerations, just which system is the best cannot be said, many persons favoring steam, still others favoring hot water, while for smaller buildings the hot air system is advocated by still others.

Since by far the most of buildings use steam heat on account of its intimate connection with the power plant, it will be the object of this article to describe a few things about steam heating systems. The systems of piping ordinarily employed provide for either a complete or a partial circulating system consisting of main and distributing pipes.

The complete circuit system, known as the one pipe system, is shown in Fig. 1. The main steam pipe is led directly to the highest part of the building; from thence distributing steam pipes are run to return risers, the return pipes entering the boiler at its lowest level. The partial circuit system is shown in Fig. 2. In this case, the main pipe rises to the highest part of the basement from whence distributing pipes run at a slight angle around the basement. The radiators are connected to the risers which carry both the flow and return. The distributing pipes are connected so as to allow the water of condensation to flow back into the boiler below the water line. In the two pipe system, shown in Fig. 3, the radiators are provided with separate flow and return pipes. The supply riser is taken from the main steam pipe and the return riser is connected to the main return below the water line. Other combinations of piping can be made of which the above arrangements form the basic systems of connection.

When exhaust steam is used from the engine in connection with the heating system, the arrangement of piping between the engine and the radiators is quite complicated. The two systems in use are the back pressure system and the vacuum system. The greater part of the heat in steam is wasted by the non-condensing engine, so that if this steam after being exhausted by the engine can be made to do heating in a feed water heater or in a building, it is just that much more heat that is turned into useful work.

Advantage is taken of this fact by either placing a back pressure valve on the exhaust line and thus obtaining some positive pressure to force the exhaust steam through the heating system or by using a system which employes a vacuum for drawing the exhaust steam through the pipes and radiators. The piping in the back pressure system can be the same so far as the radiator connections and pipes for general distribution are concerned, as those used in the ordinary systems, but all the pipes and fittings should be made as large as possible so as to reduce the pressure required for circulation as low as possible. The general arrangement of apparatus used in the back pressure system is shown in Fig. 4.

The amount of exhaust steam furnished by an engine is variable, depending on the power required of it, so that means are provided for regulating the pressure in the heating mains into which the exhaust is turned. As the amount of exhaust steam available from the engine is often not sufficient to do all the heating required in the coldest weather, means are also provided for adding live steam automatically as required to

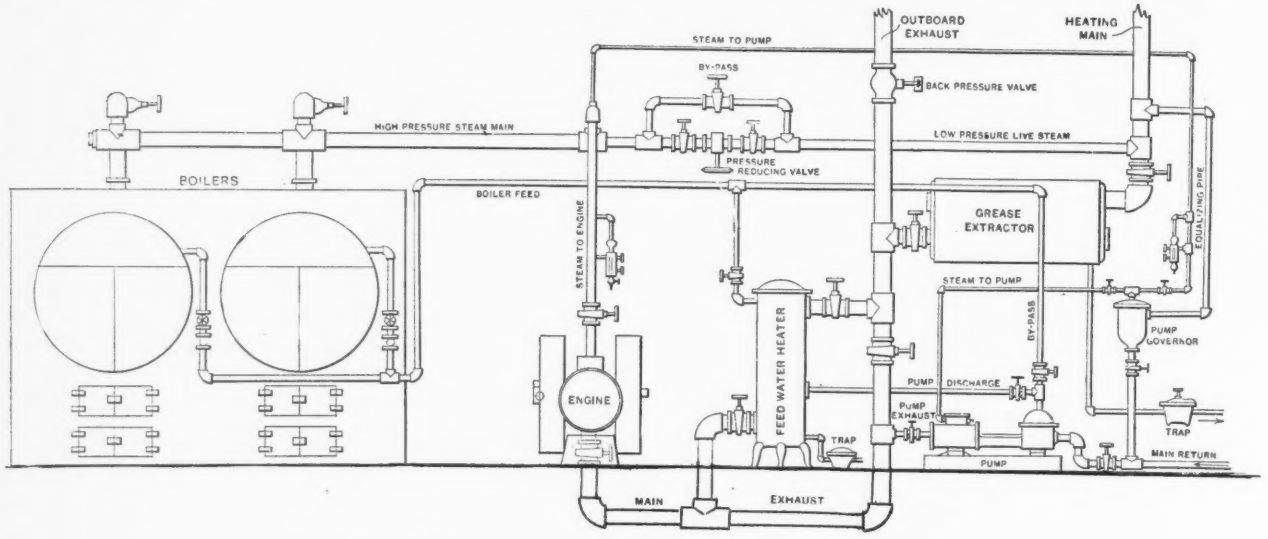


Fig. 4.

maintain an even pressure. The pressure reducing valve and back pressure valve take care of these contingencies. The back pressure valve is set by an adjustable weight or spring to open when the pressure reaches a certain maximum value and the pressure reducing valve is set to admit live steam into the heating system when the pressure drops below a certain minimum value. These two devices if set properly will automatically keep a practically constant pressure in the heating system.

Besides the piping required for the heating system, there are usually a feed water heater, grease extractor and pump attached to the system. The system as shown in sketch works as follows: The steam from the boilers goes to the engine and pump and a branch is tapped from the main to the heating main with a by-pass and reducing valve interposed. The by-pass is for use during repairs to the reducing valve, which can be cut out by the valve on either side. The exhaust from the engine is led to the feed water heater, or, it can be by-

passed around it or the valve may be adjusted so that sufficient steam will enter the heater to heat the feed water while the remainder passes directly into the heating system, as may be necessary. The condensation and oil collected in the heater are taken care of by a trap which empties them into the hot well or sewer. A connection should be made here to blow out the heater and pipes occasionally. The exhaust steam is then made to pass through a grease extractor before entering the heating system, as any surface covered with oil is a poor conductor of heat. The main return is connected to a pump which is supplied with a pump governor or a tank with an automatic float. The action of gravity in this system is depended upon to carry the water of condensation back to the return pump or receiver and the air in the radiators is forced out through the air valve by the pressure of the steam.

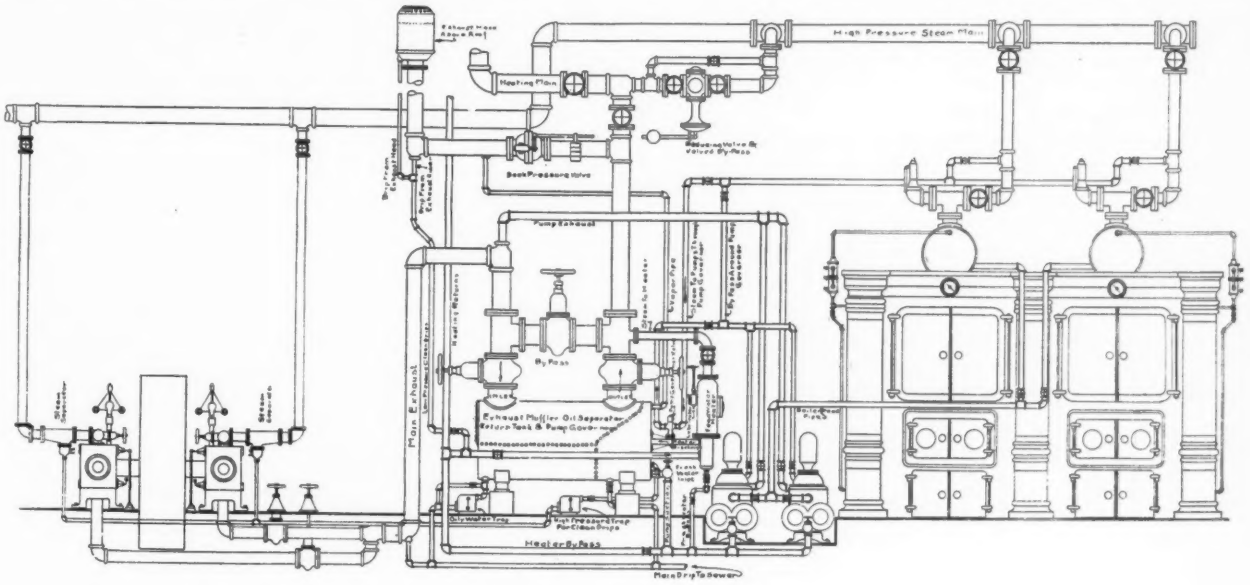


Fig. 5.

The "Utility" exhaust heating system is shown in Fig. 5. The exhaust steam from the engine enters the tank and is relieved of its oil and water, passing in a dry state into the heating system. The back pressure valve, which can be set to any pressure desired, allows the steam in the heating system never to exceed that pressure. A pressure reducing valve allows the steam to enter from the high pressure pipe when the steam pressure in the heating system falls below a predetermined limit.

The condensation from the heating system throughout the building then returns through the feed water heater to the pump governor end of tank. The governor is connected at the bottom to the suction of the pump and as fast as the condensation collects, it raises the float, which in turn opens the balance valve and starts the pump. The water is then automatically returned to the boiler by a steam pump, the steam to which is controlled by a float and a balance valve.

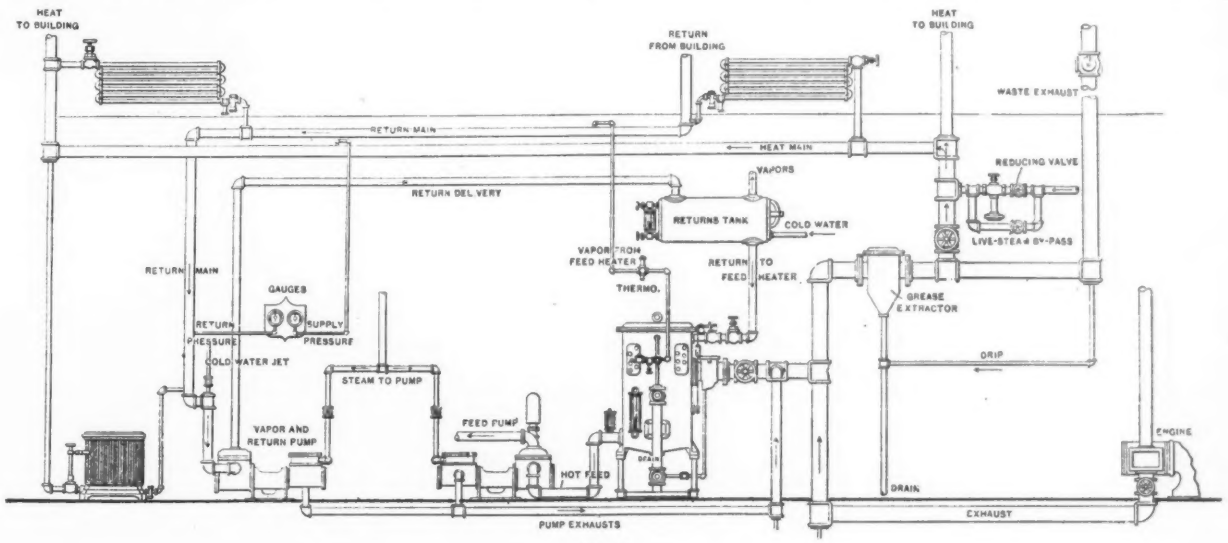


Fig. 6.

In a vacuum system the pressure in the radiators is less than that of the atmosphere and the circulation of steam

through the pipes is produced by suction rather than by pressure. It has several advantages over the back pressure system. It does away with the back pressure on the engine, it removes the air from the coils and radiators so that all portions of the system are available for heating purposes, water hammer is avoided by a complete drainage of the horizontals and returns and smaller return pipes can be used if desirable.

One of the vacuum systems in general use is known as the Webster system and is shown in Fig. 6. This system is strictly a two-pipe system as the return line is connected to the vacuum pump and by the constant vacuum maintained, the air and condensation are separated from the steam supply without the loss of steam. This is accomplished by an outlet valve which can be regulated to give any temperature in the radiators desired. They are thermostatic valves and by preventing the discharge of steam through them, the possible "short circuiting" of the circulation is avoided.

In the Webster system, as shown, the exhaust steam is piped from the engine, one branch of which goes to the feed water heater while the other is carried upward and through the grease extractor, after which it branches into two lines, one connected to the heating mains and the other connected to exhaust pipe on which there is a back pressure valve. Live steam can also be introduced into the heating main by means of a reducing valve and by-pass, as shown. After the steam is distributed to the radiators and coils in the usual manner, it passes through them at a speed largely dependent upon the automatic thermostatic valves placed where it is usual to find the outlet valve of the radiator. The main return is brought down to a vacuum pump which discharges into a return tank where the air passes off through the vapor pipe at the top. The condensation flows into the feed water heater, from which it is automatically pumped back into the boiler, the exhaust from the pump going to the heating system. A small cold water jet is connected into the suction of the vacuum pump for the purpose of increasing the vacuum in the heating systen by a partial condensation of steam at this point.

CONNECTING ROD STUB ENDS

Construction and Keying-up of the Brasses

The mechanism of the steam engine is so arranged that the power of the engine is concentrated on the crosshead pin and crank pin and consequently the wear on the brasses at these two points is considerable. The pins are usually made of steel carefully hardened and it is desirable that they should not be worn by the friction concentrated upon them, but that the wear should come upon the surfaces which bear upon the pins. It is also desirable that the construction of these bearing surfaces should be so arranged that the wear may be taken up to prevent lost motion and pounding and when worn out, they can be easily and cheaply replaced.

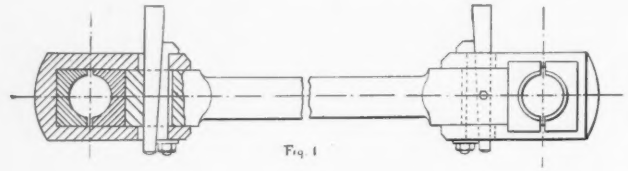


Fig. 1

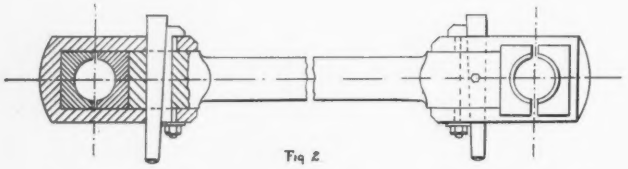


Fig. 2

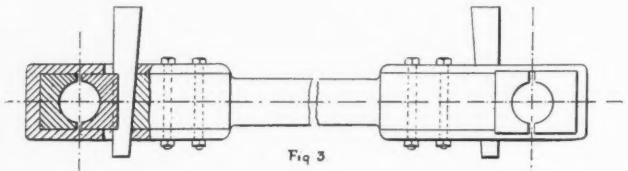


Fig. 3

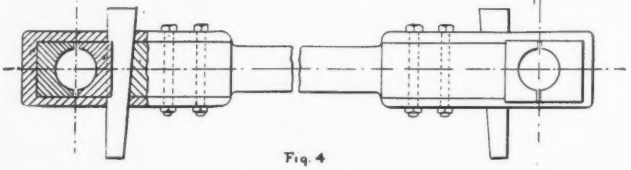


Fig. 4

These conditions have brought about an especial appliance, which is used upon nearly all engines, and which is a combination of brasses, strap, gib, key or cotter and wedge, known as the stub-end of the connecting rod. The brasses, as they are usually called, may be made of bronze, brass, or other material, made with recesses into which Babbitt metal is cast. They are called brasses no matter of what material they are composed, even if made out of cast iron. They are made in halves, which form the bearing.

A brass or bronze bearing has various properties, which have made its use so extensive, among which may be mentioned the ease with which it can be cast and tooled, its softness compared with the steel pin, its comparatively low coefficient of friction and its high conductivity of heat, which draws the heat of friction from the pins.

The brasses should touch each other at point which divides the bearing in half and as the bearing wears and lost motion begins, the brasses should be scraped or filed down until the wear or lost motion is taken up. Another plan is to use liners of different thicknesses, which may be taken out as the bearing wears. If the brasses are left with an opening between them, there is the likelihood of cramping the bearing upon the pin when the wear is taken up, which will cause undue friction and consequent overheating. The wear is usually taken up by the combination known as the gib and key or cotter, and the ends of the connecting rod are known as open or closed ends, depending upon whether the connecting rod strap is movable or not. Fig. 1 shows a form of open stub. With this form of end, the effect of driving down the key will be to draw the

strap back, since the gib bears upon the strap. By drawing back the strap, the joint in the brasses closes together. A set screw keeps the key from falling out. If the open stubs are used on both ends of a connecting rod, its length is shortened by driving the keys, the effect of which is shown in Fig. 2.

A stub end is called closed when the gib or key bears against the inner brass, as shown in Fig. 3. As the key is driven down to take up the lost motion, the inner brass moves toward the

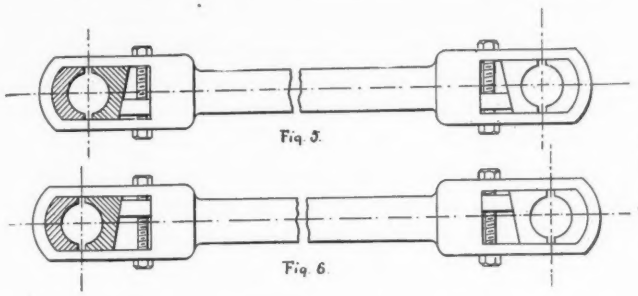


Fig. 5.

Fig. 6.

outer one and away from the centre and thus lengthens the rod when wear is taken up, as shown in Fig. 4.

Fig. 5 is another arrangement of a closed stub. The key is operated by a screw and bears against the inner brass. As the wear is taken up, the inner brass moves toward the outer one and the effective length of rod is increased.

The effect of altering the length of the connecting rod is to alter the position of the piston in the cylinder. If carried to excess, or if there was not sufficient mechanical clearance left in the cylinder between the cylinder heads and the piston, the effect would be that the piston would knock against the cylinder head when the crank is at the dead point. With an open stub, since the effective length of the rod is shortened, the tendency would be to draw the piston toward the crank end, when the wear is taken up, and when the closed stub is keyed up the effect is to push the piston nearer the head end of the cylinder.

In order to restore the rod to the proper length, when the closed form of construction is used, small distance pieces or

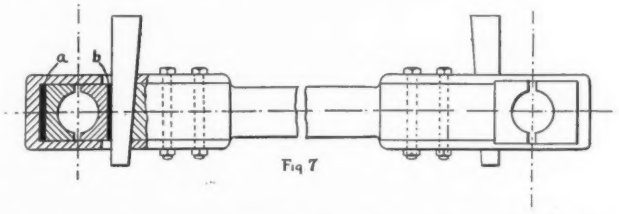


Fig 7

shims must be placed behind the outside brass, as shown at *a*, Fig. 7. Where the brasses have been repeatedly keyed up and shims have been placed behind the outside brasses to preserve the proper length of the rod, it frequently becomes necessary to raise the key in order to obtain a further adjustment of the inside brasses. In this case a shim must be placed behind the inside brasses, as shown at *b*, Fig. 7. With the open stub construction, shims must be placed behind the inside brasses to maintain a constant length of rod if found necessary.

For these reasons, it frequently happens that connecting rods are equipped with both the open and closed stub construction, the one being placed on the crank pin and the other on the crosshead pin so that the wear of both brasses is taken up in the same direction and a uniform distance between crosshead pin and crank pin maintained.

In the design of an engine, it is usual to allow a mechanical clearance in the cylinder of from 1-16 inch to ⅛ inch for each working joint between the piston and main shaft, so that any variation in the length of the rod is allowed for, but in keying up a rod it is always well to know just what is taking place in case any unlooked-for trouble may arise.

Rules for Preparing Boilers for Inspection.

Haul fires and all ashes from furnaces and ash-pits.

If time will permit, allow boiler and settings to cool gradually until there is no steam pressure, then allow water to run out of boilers. It is best that steam pressure should not exceed ten pounds if used to blow water out.

Inside of boiler should be washed through man-holes and hand-holes by hose service and dried with wiping.

Keep safety valve and gauge-cocks open.

Take off man-hole and hand-hole plates as soon as possible after steam is out of boiler, so that the boiler may cool sufficiently for examination; also keep all doors shut about boilers and settings, except the furnace and ash-pit doors. Keep dampers open in pipes and chimneys.

Have all ashes removed from under boilers and have fire surfaces and heads swept clean.

Have spare packing ready for use on man-hole and hand-hole plates if the old packing is made useless in taking off or is burned. The boiler attendant must take off and replace these plates.

Keep all the windows and doors to boiler room open after fires are hauled so that boilers and settings may cool as quickly as possible.

The inside and outside of the boiler should be allowed to cool at the same time, thus equalizing the process of contraction.

Electrical Equivalents.

One watt	=	1.0	ampere per second at one volt.
	=	.7373	foot pounds per second.
	=	44.238	foot pounds per minute.
	=	2654.28	foot pounds per hour.
	=	.00134	horse power.
One kilowatt	=	737.3	foot pounds per second.
	=	44,238.	foot pounds per minute.
	=	1.34	horse power.
One horse power	=	550	foot pounds per second.
	=	33,000	foot pounds per minute.
	=	746	watts.
	=	.746	kilowatt.

Aluminum Wires.

For the past four or five years, aluminum wires have been used in several large power transmission plants. The principal advantage possessed by aluminum is its lightness. Its resistance is greater than copper, as its conductivity is only about 60 per cent. as much. When used with alternating current circuits, its greater diameter for a given resistance as compared with copper of equal resistance gives it a lower inductance, so that the impedence is lower for an aluminum wire than for a copper wire of equal resistance.

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The Use of Tail-rods for Horizontal Engines.

One of the inherent objections to the horizontal type of engine has been that owing to the excess of friction on the bottom elements of the cylinder, due to the weight of the piston, the cylinder bore will wear oval with its long axis vertical. This wearing out of round of the cylinder has cost many thousands of dollars in reboring, bushing and renewing cylinders, not to mention the cost of the delays necessary to make such changes and the probable leakage of steam past the piston before its rotundity was re-established. This applies more especially to large engines where the large weight of the piston supported on the end of the piston rod is an important matter for consideration.

To overcome this difficulty as much as possible, pistons are made wide so that the pressure per square inch on the cylinder is small, or the piston rod is extended out through the head end which not only acts as a support but serves to guide the piston effectively in the axis of the cylinder. This extension of the piston-rod is called the tail-rod.

There has always been and there still is a widespread prejudice against the use of tail-rods for horizontal engines, but just why this is, is not apparent, except it be the increased space which they take up or the poor and unmechanical arrangements which have been used, but with a proper design and substantial construction, such as are being built by several manufacturers of large engines, there seems to be no good reason why they should not come into more general use. In Europe it is rather the exception not to see large engines equipped with tail-rods, while in this country the reverse is true.

When a list of all the complaints against pistons and piston packings of various types has been considered, it will be found that the trouble is usually not due to the construction of the piston or rings but rather to the unfavorable conditions under which they must work. With the use of the tail-rod, almost any good packing should work satisfactorily.

One reason given why these rods have not more generally come into practice has been that the engine builder builds the kind of engine which he can sell and as the demand for tail-rods has been almost negative, engines equipped with them are generally not to be found in engine rooms.

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Alternating and Direct Current Motors.

That both the alternating current and direct current motors have their uses there is no doubt, which the advocates of each must admit, but considering the inroads which the alternating current motor has made in the direct current field, it is perhaps pardonable for the advocates of the alternating current motor to claim everything in sight. Each has its advantages and just which class of motor it is most desirable to use for any given purpose depends very often upon the conditions under which it must operate.

Whether the alternating or direct current motor is used in many plants depends upon whether that plant is furnishing direct or alternating current. The use of either motor under those conditions does not always give results that are satisfactory. When, however, it comes to determining the type of apparatus to be used for a complete generating, transmitting and power converting plant, then an engineering problem is encountered into which many factors enter, especially the nature of the load on the motors.

The direct current motor is admitted to be superior to the induction motor for street railway and elevator service, while for service requiring continuous operation at one or two speeds, the induction motor is far superior.

With the direct current motor, there are three types to be considered: the shunt, the compound and the series motor. A shunt motor requires a large starting current which drops off when the motor has attained its normal speed, but when a load is thrown on, it will decrease in speed. The power of a motor is its torque or turning moment multiplied by the number of revolutions, so that when the load is thrown on, its number of revolutions decrease, while its torque increases. Compound wound motors are used in silk mills and other factories where any slight variation in speed affects the character of the manufactured product. The object of compounding the coils

is to weaken the flux in the armature as the load increases. If at a given load, under the influence of shunt excitation alone, the speed would fall a certain per cent. of the speed at no load, then the armature flux must be lessened by the same percentage in order to bring the speed up to its original value.

When a motor is subjected to a heavy load on starting, as in street railway service, a series motor is far superior to other types and for work that requires large torque at different speeds, it is particularly well adapted.

Outside the question of regulation, the objections to direct current motors are its multiplicity of parts, care of the commutator, and its tendency to spark. On the other hand, an induction motor has no commutator and therefore no brushes, and consists of two parts, the stator and the rotor. The rotating field sets up induced currents in the rotor in such a direction as to give a very strong torque. These induced currents are so linked with the system that it gives a uniform speed and can stand heavy overloads. If started under load, however, they would require an excessive starting current so that either some compensating device is necessary to cut down the starting voltage until it has attained a speed appropriate to the higher voltage or else the motor must be allowed to start without any load and the load thrown on after the motor has attained a certain speed.

The principal objection to altering the speed of an induction motor is its reduced efficiency. The speed can be varied either by altering the voltage impressed upon the stator, by altering the resistance of the rotor current or by commutating the stator windings so as to alter the multipolarity. Lessening the voltage impressed upon the stator lessens the flux and also the rotor current and increasing the resistance of the rotor circuit decreases the rotor current and requires a drop in speed to restore its value, both of which result in inefficient operation. Changes in the multipolarity require complicated commutating devices which it is the purpose of this type of motor to avoid.

As stated above, each type of motor has its particular advantages and in the more modern plants, advantage is taken of this fact by installing both alternating and direct current apparatus so that each type of motor can be used where it is best adapted.

The Liquid Air Bubble.

When it was first discovered, or rather, when the public's attention was first drawn to the fact that the air we breathe, the air which storms from the north and whose gentle zephyrs blow from the south, could be imprisoned in the walls of an open tumbler, when it was shown that one pound of the ever-prevailing atmosphere was capable of exerting enormous latent energy when liquefied, extravagant were the ideas of its various applications. It was claimed that no longer would the steam boiler with its chronic ills be the source of power for driving the wheels of industry, no longer would multi-cylinder engines be required to develop large powers and so great were the predictions made several years ago, that liquid air was heralded as being destined to work wonders.

As a result, companies were formed to sell stock to the public, and many people were led to believe that it might ultimately work something like a revolution by the expansive power which this intensely cold substance exerted as it gradually returned to its normal state. In addition, it was confidently asserted that the methods of manufacturing it would soon be so developed that it would be possible to cool houses in the heat of summer as readily as they are now warmed in winter.

But the liquid air bubble has burst. From outside of its beautiful iridescent walls there now appears nothing but gloom within, especially to the many people who were the too ready victims of the speculator. The recent statement that even the employes have brought suit to get their salaries from a concern formed to demonstrate that liquid air had practical value as a motor power shows how completely has this scheme collapsed.

The liquefaction of air is a real achievement, and all praise is due to those that realized it, but it is nothing more than had been expected by the scientists years before. It had been accomplished many times by different experimenters long before the bubble began to grow in the public eyes and had never been manufactured on a large scale because the results obtained were not thought to be worth the effort, as these men of science realized that more energy must be expended in liquefying the air than is given out by the re-expansion of the resultant liquid.

That liquid air has its uses there is no doubt, but its availability for motor power in driving machinery has never been successfully realized as the enormous pressure and very low temperature required in producing the liquefied product have allowed losses to enter which are not recoverable, so that the final efficiency is very much less than expected.

The adherents of the liquid air bubble are not, however, the only persons who have thought that their scheme of utilizing the energy of the elements would transplant the use of steam as a motive power. Too often what has been considered to be the phosphorescence of wisdom has been in reality the incandescence of ignorance.

A kerosene hoisting engine is now manufactured that is stated to be giving perfect satisfaction. Engines of this type, ranging from two horse power to thirty horse power, are employed for various purposes, such as driving threshing machines, water and air pumps, etc. Their adaptation to driving portable stone crushers, to concrete mixers, and other contract use where an engine of moderate power is required, is a matter of detail, and they should certainly be received with favor among contractors.

THE ACTION OF STEAM IN THE CYLINDER

By R. T. Strohm.

Every engineer knows, in a general way at least, what takes place in the cylinder of the engine of which he has charge. There is a period of admission and a period of exhaust, and between these two lies a short interval during which the steam expands from a higher to a lower pressure, forcing the piston along and producing motion at the expense of a part of its heat energy. But this is not all. This outline, while it covers the bare facts, and gives the most apparent portions of the action of the steam in the cylinder, is far from being the whole truth. It may be both interesting and profitable, therefore, to examine more closely into the subject and to note some facts which do not appear to the casual observer as he watches a running engine.

When steam from the boiler is admitted to the cylinder the piston has not quite reached the end of its stroke. The distance which remains, however, is very slight, and, so far as the action of the steam is concerned, the crank may be considered as being on dead centre, which would be the condition at admission with a valve having no lead. The steam which fills the clearance space at the beginning of the stroke is of comparatively small volume. For the distance between the piston and the nearest cylinder head at this point in the stroke is not over ½ inch, even in large engines, and in small engines much less. But the surface which bounds this steam volume is very great in proportion to the volume enclosed. Consequently, as the metal of the cylinder and piston is cooler than the steam, the immediate effect upon the steam is to chill it and cause a portion of it to condense. And the extremely large ratio of cooling surface to steam volume makes this condensation all the more rapid.

For example, assume an engine whose cylinder is 10 inches in diameter and 18 inches long, with a clearance of 6 per cent., which is so divided between the volume in the end of the cylinder and that in the steam port, that the former has 1 per cent. and the latter 5 per cent. The distance between piston and cylinder head is then 3-16-inch and the volume in the end of the cylinder is 14.13 cubic inches. The volume of steam in the steam port is 70.69 cubic inches, making 84.82 cubic inches of clearance volume. The cooling surface to which this volume is exposed is about 255 square inches, taking the port surface at 102 square inches. It is evident, therefore, that for each cubic inch of steam there is $255 \div 84.82 = 3$ square inches of exposed surface from which the heat in the steam may be conducted. The smaller the cylinder, or the less the percentage of clearance, the larger this ratio becomes.

As the piston moves forward, it uncovers still more cylinder surface which is comparatively cool and the condensation continues, although the ratio of surface to volume grows less. Now, the only cause of condensation is loss of heat, and if heat is lost from the steam it must be absorbed elsewhere, since it cannot be destroyed. The heat which is taken out of the steam goes into the cylinder walls, cylinder head, piston and all parts in contact with the steam, thereby raising their temperature until it is practically equal to that of the steam.

At cut-off, then, the cylinder walls are but slightly cooler than the steam at the initial pressure and inside the cylinder there is a volume of steam together with a considerable amount of moisture of condensation, both at the temperature corresponding to the absolute pressure of the steam. The steam, being gaseous in its properties, exerts pressure upon the piston and moves it forward. The condensation exerts practically no pressure whatever upon the piston. Consequently it is of no value in producing work, and may be considered as a loss, since it is the result of giving up heat which did not perform any useful work. In any engine, the escape of heat in any other way than by its transformation into work is a loss, and if it were possible to prevent or avoid all these sources of loss, there would result an engine of maximum thermal efficiency, or a perfect heat engine.

After the valve cuts off communication between cylinder and boiler and the steam begins to expand, the pressure falls. Simultaneously there is a fall of temperature, since the temperature of saturated steam depends upon its pressure. During the expansion, work is performed upon the piston and since the heat required to do this work comes from the latent heat of the steam, a part of the steam is condensed, adding to the condensation which took place during admission.

But the temperature of the steam falls rapidly. It requires time for the heat to be conducted into the cylinder walls, so that the metal of the cylinder does not change its temperature as rapidly as does the steam. Hence, for a short time after cut-off, the walls are lower in temperature than the steam, and are absorbing heat. But, as the steam expands, with falling temperature, there comes a point at which the walls of the cylinder and the steam inside them are of the same temperature. At this point the flow of heat to the cylinder walls ceases, and there is no further condensation due to the chilling effects of the cylinder, during the stroke. For the only condition under which heat will pass from one body to another is that there shall be a difference of temperature between them.

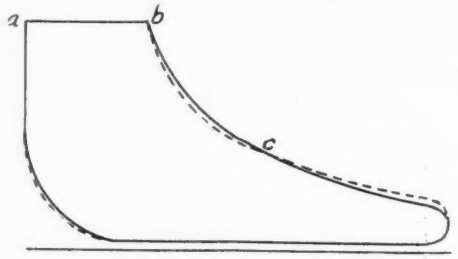


Fig. 1.

Once this point of equal temperature is passed, the steam becomes cooler than the walls, since the walls do not respond as readily to the fall of temperature as does the steam. Consequently, as heat always flows from a warmer to a cooler body, there is now a reversal of the heat current, and heat is given up to the steam from the cylinder walls. The result of this is a cooling of the walls and a re-evaporation of a portion of the moisture of condensation. This re-evaporation continues even after the exhaust valve opens, and during the ex-

haust stroke. The walls are thus cooled down to nearly the temperature of the exhaust steam.

For, in the case of the non-condensing engine, the exhaust valve opens before the end of the stroke, at which point the steam may have a pressure of several pounds above atmospheric. As soon as release occurs, the pressure falls to about 17 pounds absolute. The moisture remaining in the cylinder at the point of release has a temperature higher than the boiling point of steam at 17 pounds absolute, and as a result a portion of it flashes into steam, the heat required for this operation being furnished both by the walls of the cylinder and the heat in the water itself. Thus the temperature of the walls and of the moisture is reduced to that of the exhaust steam.

Near the end of the return stroke the exhaust port is closed, due to inside lap on the valve, and the steam remaining in the cylinder is compressed. The result is a rise of pressure and temperature. For during compression the steam is having energy expended upon it and this energy reappears in the steam in the shape of higher temperature and pressure.

There is some difference of opinion among engineers as to what the action in the compression space really is. Some hold to the belief that re-evaporation occurs. Others declare that a portion of the steam is turned back into water. Now, it is evident that both cannot be right at the same time. Yet it is probable that under certain conditions there may be re-evaporation while under different conditions condensation will occur, so that each belief will be correct according to the conditions.

First, let us suppose that the mixture caught in the compression space is steam and water at the same temperature, the amount of steam being less by weight than the amount of water. The heat equivalent of the work performed during compression is given to this mixture. Now, the specific heat of water is 1, while that of saturated steam is .305, which means that it requires .305 as much heat to raise the temperature of a pound of saturated steam one degree as to raise the temperature of a pound of water one degree. Also, the steam must be saturated as long as it is in contact with water. Consequently, when heat is added by the compression, the pressure rises far more rapidly than the temperature of the steam. Consequently, the boiling point of the water will be much higher, and the amount of water being the greater and its specific heat being greater, it will take up most of the heat of compression. If this heat is not sufficient to raise the water and the steam to the temperature corresponding to the final compression pressure, which could occur if there were a considerable amount of water, then a portion of the steam would be condensed until equilibrium would be restored, as the steam could not exist in contact with water at a lower temperature than itself. Here would be a case, then, of some steam being condensed during compression. The condition should not be an impossible one, inasmuch as the ratio of volumes of water to steam, weight for weight, at an absolute pressure of 16 pounds, is about 1 to 1600. So that a very small volume of water will weigh as much and more than a very large volume of steam.

On the other hand, suppose the weight of steam to be much in excess of the weight of water, which also may occur, if the re-evaporation is great, so as to convert most of the condensation into steam again during the exhaust period, leaving practically dry steam in the cylinder at exhaust closure. The heat of compression is then imparted to the steam and if the amount of this heat is greater than that required to raise the mixture to the higher temperature corresponding to its pressure, the extra heat will re-evaporate some of the moisture.

No matter whether re-evaporation or condensation occurs, however, there is a rise in temperature during compression, which increases the temperature of the cylinder surfaces in contact with the compressed mixture, so that at admission the fresh steam entering from the boiler does not meet with surfaces at the temperature of the exhaust, as would occur if there were no compression.

It is interesting to note the effects of these changes upon the outline of the indicator diagram. In the cards shown in Fig. 1 the solid outline represents the theoretical diagram, the expansion and compression curves being adiabatic lines. During admission, which is represented by the steam line from *a* to

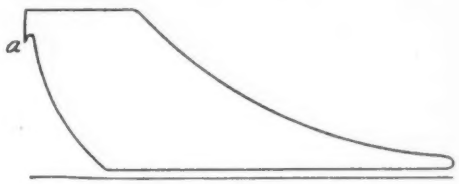


Fig. 2.

b, there is no variation between the actual and the theoretical cards, in spite of the fact that the greater part of the condensation occurs up to cut-off. For, as the cylinder is in direct communication with the boiler, any decrease of volume due to condensation is at once made up by the entrance of fresh steam at boiler pressure, so that there is no drop in the steam line.

When the valve closes, however, and condensation continues, there is no way of supplying fresh steam to take the place of that which condenses. Hence, the actual curve of expansion at once begins to fall below that of the theoretical card. The reason for this is apparent when it is remembered that the adiabatic represents expansion without gain or loss of heat to or from an external source, or the nature of an expansion taking place in a cylinder made of an absolutely non-conducting material.

Owing to re-evaporation, the amount of steam in the cylinder increases as expansion progresses, and consequently the pressure rises somewhat higher than that attained in a non-conducting cylinder. So we find that at some point *c*, the actual curve of expansion, shown dotted, crosses the adiabatic, and rises gradually above it to the end of the stroke. During exhaust the two lines will again coincide. For, although the amount of steam to be expelled is increased by the re-evaporation occurring, this is not of sufficient quantity to make any noticeable difference in the pressure, and hence in the exhaust line.

After compression begins, in the actual engine, heat is absorbed by the walls and piston and consequently the pressure is lower than if the compression were adiabatic. In other words, the heat of compression is partly expended in raising the temperature of the cylinder walls, so that it does not go wholly into the steam, as it would in adiabatic compression. Thus we may expect to find the actual curve outside the adiabatic, as indicated in the figure.

It not infrequently happens that the indicator diagram shows a kink at the end of compression, as at *a*, Fig. 2. This was attributed to a leaky valve, or piston. But when the same kink appeared on cards from engines whose steam joints were

known to be tight, a new explanation was needed. It was therefore concluded that condensation of a part of the compressed steam was responsible for the peculiar hook in the curve. This conclusion is not illogical. As the piston nears the end of its stroke, its velocity becomes rapidly less, so that during the last 15° or so of crank rotation, there is very little movement of the piston. This slowing up of the piston near the end of the stroke offers opportunity for condensation which may manifest itself by the kink shown.

It is apparent that if all the heat given up to the cylinder walls were given back to the steam during expansion, there would be the same quality of steam at the end of the stroke as at the beginning. But a portion of the heat taken from the steam is conducted through the metal walls and conveyed to the surrounding air. Lagging made of asbestos, mineral wool, dead air spaces, board or combinations of these, are used to prevent the loss of heat by radiation and convection. But it goes on, although at a diminished rate.

The amount of steam condensed by the cold surfaces will, of course, vary greatly according to the size, speed, location and condition of the engine. Experiments have shown that from 10 to 50 per cent. of the total water consumption was due to cylinder condensation. It is evident, then, that if the steam consumption is calculated from the indicator card, the result will be simply a more or less close approximation to the true consumption. For the diagram records steam volumes and pressures only, and does not indicate in any way the relative proportions of steam and water in the expanding mixture. Hence the consumption as found from the card is always too small.

When it is stated that the cylinder walls change in temperature according to the variation in steam pressure, it must not be concluded that these changes take place throughout the entire body of metal, for this is not the case. It requires time for heat to be conducted and hence the speed of the engine will have much to do with the depth to which these fluctuations extend. Experiments on a slow speed engine with 84 pounds steam pressure indicated that there was no appreciable fluctuation beyond 1-15-inch from the steam surface, and that this depth grew less as the speed was increased or the boiler pressure was lowered.

Chilled Castings.

In making chilled castings, the whole or a part of the mould is lined with cast iron, which is protected by a thin coating of loam. The cast iron lining being a comparatively good conductor of heat, chills a portion of the melted metal next to it, changing it into a hard white iron to a depth varying from one-eighth to half an inch. A casting with a chilled surface is much harder than the interior and better suited to resist wear.

Case Hardening.

If an article which is made of wrought iron is heated in contact with substances rich in carbon, such as bone dust, horn shavings, or yellow prussiate of potash, the iron at the surface will be converted into steel, which is hardened by quenching in water. This process is very often applied to the wrought iron working parts of machines after the parts are machined and finished.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

Opening and Closing Valves. Only One Side to the Question.

EDITOR THE PRACTICAL ENGINEER:

I have been reading with much interest the controversy between Mr. Wakeman and A. T., as to whether or not a wrench should be used in closing valves and like D. S. in the November issue, I feel like "butting in."

I shall not venture to accuse either of the gentlemen with insincerity in their expressed opinions because I think they really mean what they say and it makes interesting reading, but I can't see why they should spend so much time in argument over the matter when there is really only one side to the question, unless, in the first place they have "agreed to disagree."

In the first place, I think we will all admit that valves should close tight enough to prevent the passage of steam or water through them without having to use a wrench on them and when they are in perfect condition, will do so; but in my fifteen years' experience I have yet to see the valve that will not wear more or less and become "leaky" with constant use, some makes much more quickly than others.

I think we will also agree that the proper thing to do when a valve becomes leaky is to repair it or replace it with a new one at the first opportunity, but the opportunity for repairs does not always arrive when the valve begins to leak and should it become necessary, in the meantime, to close the valve absolutely steam or water tight, how many engineers are there who would not resort to the moderate use of a wrench when the grip of his hands does not produce the required result, and, by doing so, prevent the loss of several hours time or, possibly, a shut down of the entire plant?

Should the question as to whether or not it is advisable to use a wrench on a valve be put to one hundred first-class engineers, I venture to say at least ninety-nine of them would answer: "Never use a wrench on a valve when it is possible to close it without one. Otherwise *use the wrench*, exercising proper care and judgment in doing so in order that the valve is not permanently injured."

Clearfield, Pa. S. B. S.

Opening and Closing Valves. Different Conditions Exist in Different Plants.

EDITOR THE PRACTICAL ENGINEER:

Every month for the past year I have read your most valuable paper, noting with much interest, letters from engineers throughout this vast country.

The article on "Opening and Closing Valves" has been under discussion for some time and I think that we must all admit

that different conditions exist in different plants. Engineers, as a rule, do not have the power to purchase and install new valves or make other repairs when they can get along with those that are in use. Superintendents wish to keep the expense sheet as low as possible, so that the engineer becomes accustomed to working with what he has, making frequent suggestions and obtaining only such repairs as are absolutely necessary and providing nothing serious happens, he is given the credit of being a good, competent engineer.

Plants that run 24 hours per day, where more than one man has charge of things, are somewhat different from those where they run 60 hours or less per week. I, for one, would not hesitate to use a wrench on a valve if necessary any sooner than on a nut on an anchor bolt, where, if enough leverage was used, you could thread strip the bolt.

The poetry written by J. J. H. in your paper deserves great credit, as it is on a subject that interests us all. "Rodney's Troubles" also brightens up the gloom. Kindly consider me one of your many well-pleased subscribers.

Goshen, Ind. H. A. B.

Opening and Closing Valves. Stationary versus Marine Firemen.

EDITOR THE PRACTICAL ENGINEER:

Having read the articles of Mr. Wakeman and A. T., I thought I might say a little something that might help settle the discussion somewhat. I think A. T. is right in his statements and that any good practical man will bear him out in the same. Not very long ago I took a temporary position as engineer of a third-class plant and while there saw all I wanted of valves that had been closed with a wrench. There were some ninety odd valves in the engine room and *not one* of these could be closed tight with the hand.

Arrangement for Closing Valves.

One day, I found an old valve in the machine shop and thought I would take the bonnet off to see what it looked like, which I did, and found the seat sheared to such an extent that it could not hold steam or water. I once asked the old engineer why he used a wrench on the valves and he replied: "Oh! some of them got to leaking, so I made a wrench and used it on them all." His wrench was made a good deal like a bit and brace and resembled the sketch, so that is how they all got to be in the same condition.

The engineer was a good, careful man and had wide experience, both marine and stationary. He had a few valves that leaked in spite of the wrench but these, he said, would not hurt anything, as he did not consider there was any harm done by a few dripping water valves. Later on, I went into another plant and there the valves were the same way but this time it was due to carelessness, as the engineer did not even take pains to see that his gauge glass showed water. I asked him if he was not afraid that his fusible plug would melt out and he said he did not think it would melt out, anyway.

But speaking of valves, it seems to me that if the manufacturers of the valves intended there should be such a strain put on them as there is when a monkey wrench is used, they would have made the wheels large enough so that the wrench could be dispensed with.

In another article I saw something about the duties of a marine fireman being limited to shoveling coal. I guess the writer of that article never had much experience on marine work. If he had, he would know better than to make such a statement. I have had some experience as a marine fireman myself on an auxiliary vessel and had to learn to tie some thirty practical knots, to make sennet for seizings, learn the uses and names of all the ropes on the ship and where to find them on a dark night and as there were some one hundred and eighty of these, this was no light task and took time. I had to learn to splice ropes, rig the boats and sail them. In the fireroom, I had as much or more to do than the stationary fireman has.

We had compound condensing engines of 800 horse power and had three watches, each of which consisted of five firemen, two engineers, two oilers, four coal passers, a log keeper, an evaporator man and a man to run the dynamo. If the writer of the article bearing on the duties of a marine fireman will read this, he may change his mind on the subject.

E. Whitman, Mass. A. C.

Knows that A. T. Does Not Use a Wrench on Valves.

EDITOR THE PRACTICAL ENGINEER:

Enclosed find my subscription to your magazine. You have without doubt the best one for the money to be found in the country and as good as some that cost much more.

I have been much interested in the argument between Mr. Wakeman and A. T., as I have worked under A. T. as assistant engineer for the last four years. I can say that A. T. knows how to run a steam plant and how to take care of his valves and I will say that no wrenches are used on the valves.

I hope your paper will grow as fast in the coming year as it has in the past one.

No. Abington, Mass. C. W. ALDEN.

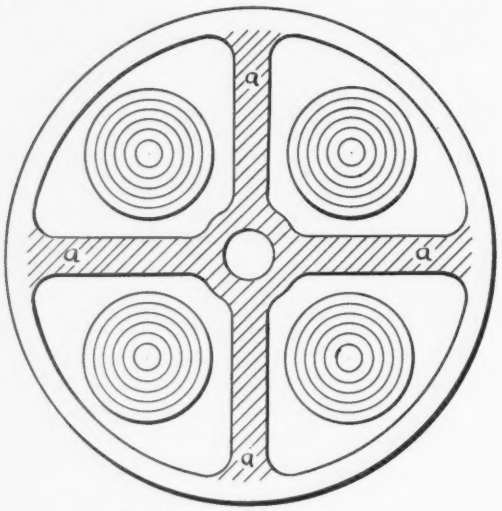
As Things Are Often Done.

EDITOR THE PRACTICAL ENGINEER:

It being necessary to install a larger pump and larger receiver to handle the returns after a certain factory had been enlarged a few years ago, a 6" x 4" x 6" duplex pump was bought and set up. Great care was taken to have everything properly installed and when finished it was a good job and was much praised by a number of engineers who came in from time to time, as every detail had been taken into consideration in regard to easy access for repairs and management.

This pump worked very nicely for a while and I was quite proud of it, but while the assistant and I were one afternoon standing nearby, engaged in conversation, this pump gave out and would not force any water even from the pet cock on the cover and we worked for quite a while but could do nothing with it. After an examination we found the packing had washed off the cross bars. Having found this, it was soon replaced with a new gasket and the pump started again, but the pump had to run at a much higher speed than before to

handle the returns. In a few days this gasket let go and I renewed it with one of the strongest kinds of sheet packing that I could get but it continued to churn the water and loose gaskets, so I put a straight-edge on the cross-bars of the valve and found I could see between the bars and the straight-edge. Knowing that I had found out the real cause of the trouble,



Repair to Lower Pump Valve.

I called the manufacturers of the pump up over the telephone and explained my trouble and what I had found to be the cause. They told me I must be wrong and felt sure I was badly mistaken but they would send a man to look it over and repair it. The man came and examined it and found it was just as I had said, so this man took a chisel and cut up the faced off part of the bars in the manner as shown in cut at *a*. This cut represents the lower valves in pump. The valve plate was cut in the same manner, but it was very little help to the pump. It held the gasket on for a long time but the pump had to work very fast to keep up the required amount of water. The pump finally had to be sent to the shop and be planed off and new valve plates put on. This cured the trouble, but as I expected, the chisel did not do, as was expected by that firm.

An engineer came to my engine room one afternoon and asked me if I would go to his place and see what was the trouble with his pump. He said he had been making some repairs and the pump would not start, but he could not see what was the real cause of it. When I got to his engine house I looked at the pump a minute and asked what was the nature of the repairs on the pump? He said: "I put some new pipe in the feed line but the pipe was all clear." I looked the pump over again and noticed that a new gasket had been put on the steam chest, and I asked: "Have you just put that gasket in new to-day?" "Yes," he said; "but that is all right." "Well, let us look it over," said I, and sure enough he had not cut out for the auxiliary holes, and he also had the feed valve closed on his feed pipe. He had forgotten to open it. This fellow felt bad over the matter.

It is just as well to tell of our own ignorance as to criticise others, so I will tell of an experience of my own. I had not been running more than six months as assistant engineer and was on the night shift in a rolling mill, and as luck would have it, I was all alone this night. The other part of the mill was short of iron, due to a break-down at the rolls on the end I was running on. About midnight the boiler feed pump, which was a duplex, gave out on one side. The packing in one of the water pistons was done and wanted to be renewed. Well, to save me, I did not know what to do. The side that had lost the packing was making some great strides, while the other side seemed to take it easy. I was sure something had gone wrong with the steam end, so I stopped the pump and removed the steam chest cover to see what was the cause, but not being familiar enough with the pump, I decided not to make any changes but sent a fireman for the chief engineer. He came in and was not feeling very good about being disturbed at that hour, and when he saw what was the trouble, said: "You had better take a few lessons on pumps if you want to hold your job down here, for I don't intend to be routed out of bed at all hours of the night for such a foolish thing as this."

I felt sore, so to speak, and made my mind up he would not be bothered by me on anything soon if I could help it.

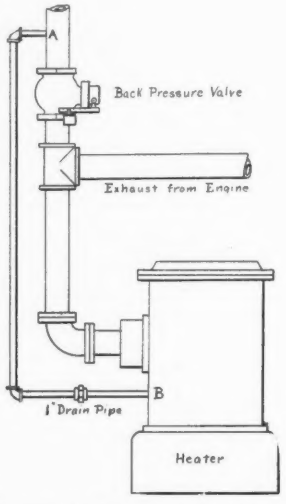
North Abington, Mass. A. T.

—o—

Oil in Boilers Caused by Improperly Connected Drains.

EDITOR THE PRACTICAL ENGINEER:

I met a peculiar condition of affairs connected with an open heater, in an engine room, the other day, and I think it worthy of mention in your valuable magazine. The engineer called my attention to one of the boilers that he had just opened, and there was a great deal of oil on the shell near the water line, showing that the exhaust line oil separators or the heater were not doing their work properly. I disconnected the drain pipe from separator to sewer to find the separator doing its work nicely. I then turned my attention to the heater. After letting out all the water and arranging the pump to feed with cold water direct from the street main, I opened the coke chamber, or filtering chamber rather, and on examination found that the



Improperly Connected Drain Pipe.

coke was doing its duty all right, but still there was a great deal of oil getting into the heater from somewhere. I then began a careful questioning of the engineer regarding how much cylinder oil he used and found that he was not using more than was necessary. I then looked over the piping to the heater, and found the source of all the trouble.

In the sketch at A, a pipe 1" diameter led to the heater at B. When the engine was running under a light load a water pocket would form over the back pressure valve and fill the exhaust pipe to the drain pipe at A. The oil would naturally float to the top of the water and readily find its way to the heater, and to a part of the heater that performed no filtering, consequently the oil soon found its way to the boilers. This pipe was disconnected from the heater, a plug put in the side of the heater where it had entered, and the drain pipe led to the sewer. The results were good and there was no more trouble from oil in the boilers at that plant.

Arkansaw, Wes.

Efficiency Test of a Boiler. Safety Valves.

EDITOR THE PRACTICAL ENGINEER:

In reply to the query of C. S., North Menomonie, Wis., in the September issue of "The Practical Engineer," it is necessary in the first case to hold an efficiency or horse power test. The reason for this is very apparent when it is considered that the various types and makes of boilers generate steam at different pressures, different degrees of dryness and also different feed water temperatures. This being understood, it follows that before the standard horse power of a boiler can be found, the evaporation must be reduced to a common basis for all, which is the equivalent evaporation from and at 212 degrees. Standard horse power is then obtained by dividing the equivalent evaporation by 34½, which represents the number of pounds of water evaporated from and at 212 degrees. This has been agreed upon by the American Society of Mechanical Engineers as the unit of standard boiler horse power.

To find the efficiency, which is really the combined efficiency of the furnace and boiler, it is necessary to determine the amount of heat supplied, which can be done by accurately weighing the fuel used, deducting all the ash and unconsumed portions. This weight in pounds is multiplied by the total heat of combustion of a pound of fuel, as determined by analysis, the product being the total number of heat units supplied during the test under the assumption that combustion was perfect. The heat usually expended in evaporating water is obtained by first weighing the feed water and correcting this said weight by the quality of the steam. The corrected weight is then multiplied by the number of heat units required to change water at the temperature of the feed into steam at the observed pressure.

To find the efficiency of a boiler expressed in per cent., the following formula may be applied:

$$E = \frac{100\,A}{B}$$

in which E = efficiency of boiler, A = heat units usefully expended and B = heat units applied. The equivalent evaopration can now be found from the following:

$$w = \frac{W(H - t + 32)}{966.1}$$

in which W = actual evaporation, H = total heat of steam above 32° at observed pressure of evaporation, t = observed feed water temperature, w = equivalent evaporation from and at 212° F., then $w \div 34.5$ = standard boiler horse power.

In answer to the size or area of the safety valve, the formula expressed in the September number of "The Practical Engineer" is prescribed for natural draft. There are other formulas used under varying conditions, viz.:

For artificial draft, $A = \frac{1.406\,w}{P + 8.62}$

For lever safety valves, $A = .5\,G$

For Pop valves, $A = \frac{G}{3}$

Prof. Thurston, of Cornell, proposes:

$$A = \frac{.5\,W}{P + 10}$$

in which G = grate surface in square feet, P = steam gauge pressure, W = weights of steam generated in pounds, w = weight of coal burned per hour, A = least area of safety valve in square inches.

Silver City, New Mexico. EDWARD LEECH.

How Should Valves be Connected on Steam Boilers?

EDITOR THE PRACTICAL ENGINEER:

In the letter in the October "Practical Engineer" "How Should Valves be Connected on Steam Boilers?" by Mr. Sheridan, he says: "This question is deserving of consideration and thought," with which I can heartily agree, but I can not agree with him when he says the pressure should be on top of the disc. He says: "The lives of attendants as well as the lives of employees of a factory should be considered," which is very true. There are also the lives of those who have to clean and repair the boilers with which the valves are connected to be taken into consideration, and with this fact in view, I believe I can presently show that what Mr. Sheridan considers good practice becomes doubly bad practice.

I know of only one place where I would recommend to connect a valve with the pressure on top and that is in the feed pipe between the check valve and boiler. It is very convenient to have it connected up thus at this point, for then, if from any cause the disc should become detached from the stem, water could still be fed in to the boiler, while, if the valve was connected up with the pressure from the boiler on the under side and the disc was detached from the stem, the pressure from the pump would force the disc on the seat and no water could be put in the boiler until the valve was repaired, which would necessitate a shut down of the boiler.

I know most engineers give as the chief reason why the pressure should be on the under side is that the stem can then be packed when steam is on the boiler. To my mind, this is the least of many reasons why the pressure should be on the under side, especially when more than one boiler is connected to the same steam line. Even with only one boiler and one steam line, I prefer to have the valve connected up with the pressure on the under side, if for no other reason than the following incident will serve to illustrate:

In a plant where I was employed at one time, we had two boilers but only one was in use at a time. One night we wanted to close the stop valve on the boiler in use, as we wished to make some alterations to the steam line. On attempting to close the valve, which was a six-inch globe valve, we found we could not close it sufficiently to allow us to work at the

pipe. The following day the idle boiler was started up, put in service and the other allowed to cool off. An inspection of the valve showed the disc detached from the stem. Had this valve had the pressure on the top instead of on the under side at the very instant the disc became detached from the stem, the steam pressure would have forced it down on the seat and the plant would have been out of business until we could have raised steam on the other boiler, or in case of only one boiler, until the steam was gotten out of the boiler and the defect remedied.

Some engineers put globe valves on the blow-off pipe, which is bad practice at best, but if this valve is put on with the pressure on top a bad practice is made much worse, for in this case should the disc be detached from the stem, the boiler could not be blown down, which would allow the scale and sediment to collect in the blow pipe and undoubtedly a burned and burst blow-off pipe would be the result, which in all probability would injure more people than a half-dozen stripped valve stems.

We will now take the matter into consideration where two or more boilers are connected to the same steam line. In this case the pressure has to be on the under side of the disc from one way or the other, and I much prefer to have it on the under side from the boiler. If the pressure from the boiler is on top of the disc, the pressure from the main is on the under side of the disc. When any of the boilers are laid off for cleaning or repairs, the danger of a stripped stem becomes two-fold. Should a man be in the boiler for the purpose of cleaning or making repairs and the thread be stripped from the stem—as suggested by Mr. Sheridan—not only those outside would be liable to be injured, but it would be almost a miracle if the man inside escaped with his life.

One other point in favor of having the pressure on the under side of the valve when two or more boilers are in use is this: When all of the boilers are in use and it becomes necessary to close one of the valves, of course the pressure will be equal on both sides; therefore, the strain on the stem will not be very great, and as soon as the pressure is off of the boiler there is no more strain on the stem and so long as the pressure remained on the main steam line it would make but little difference if there was a stem on the disc or not, while if the valve had the pressure on the under side from the main the danger would be as described above.

If a good make of valve is bought in the first place, used for what it was intended, and for the steam pressure for which it was designed and last, but not least, by any means properly cared for it will give about as little trouble as anything around a steam plant. This is my opinion regarding the matter and I should be very glad to hear that of others on the same subject, as I believe these discussions are beneficial to us all.

Poughkeepsie, N. Y. A. K. VALVE.

———o———

What is the Trouble? Answer to H. J. I.'s Question in November Issue.

EDITOR THE PRACTICAL ENGINEER:

I am well pleased with "The Practical Engineer" and read with much interest the many letters and articles from engineers contained therein.

I note H. J. I.'s, Stockton, N. Y., question "What is the Trouble?" in the November issue. I will say that I had a similar experience in the case of an engine 9" x 14". The engine stopped almost instantly, and I could not turn the wheel even with the belt off. I removed the cylinder cover, disconnected the piston rod from the crosshead, and it required considerable effort to drive the piston out.

I found that the tip end of one packing ring had broken off and turned in place so as to form a wedge, thus taking up all lost motion between the piston and walls of the cylinder and creating great friction and damage to the latter.

I offer this as one case that might have happened to H. J. I. In fact, it seems that the trouble he speaks of could only be in the cylinder. A thorough examination would, of course, reveal more than theories.

Clinton, Ia. L. A. H.

———o———

Rodney's Troubles.
Or Do We Need a License Law in Michigan?

(Fifteenth Letter.)

Mr. editur, deer sur, ure kind lettur tellin' about the differunce between a high preshur injine and a low preshur injine wuz reseeved last munday and it did me a lot ov good tu sho it tu henry, tu pruve tu him thet i wuz rite about what kind ov a injine mine iz. but there iz one word in ure letter thet i dont jist ketch and it iz the word exhaust, where u say the exhaust steam from the cylinder escapes to the atmosphere. now old man garfel has been runnin graves saw mil for close on tu 20 yeers and he sez ure jist usen a new fangled name fur the escaping steam. he calls it the disaust steam, he sez thet he nos he iz rite fur he sez the word disaust is like the word discharge and means to put out, or force frum. now pleeze tell me whut the differunce iz between exhaust and disaust. the biler inspectur woz up tu se me last weak 1 day and he and henry were havin a argument about steam injine valvs, ekonomi, cut offs and a lot ov uther things about a steam injine. now then i wood lik tu no what the point ov cut off iz on my injine. i kant find it enny whare. ive looked in every plase i can think ov and i dont kare to git ketchd sum time and luze my hand or fut, fur the only plase that i can remembur whear i node ov enny sich a thing az a cut off arrangmunt bein on mi injine wuz when i wuz runnin a feed kutter at eph bowens kuttin feed fur hiz kattle when ephs boy ketchd hiz hand in the kutter and hed 3 fingurs tuk off. so i wood ov korse be a bit skart at enny such a thing ef it wood be likly tu hapen tu me.

onli last wintur when i wuz up tu the power house 1 day i remembur the cheef tellin a fellar thet 1 ov the nu injines tha wuz puttin in wuz a varry abel cut off tipe and it wuz onli a fu days aftur that when 1 ov the oilurs hed hiz three fingurs cut off hiz rite hand. the cheef told the fellar that the oilur got hiz hand kot in a ecksiter and ile jist bet he got it in the nu fangld cut off injine. i shood think that thare wood be some kind ov a law to purtekt men frum gettin kot in such plases but i suppose then kind ov injines are a cheep kind and the big kumpanys by them never thinking enny thing about the help az haz tu run em. hopen i wil heer frum u sune i remane

ures trooly
rodney gumkirk
orkners korners
munrow kounty mishegan
care mi father

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

Answer to A. B. C.'s Question in August Issue.

EDITOR THE PRACTICAL ENGINEER:

In reply to A. B. C., of New Bedford, Mass., as to the feed water problem, I would beg to submit the following:

The conditions A. B. C. has assumed would not, of course, naturally occur in practice and therefore there can be no practical value to the question. Further, I do not think it is possible to compute the pressure in the coil with any degree of accuracy. The simplest way of determining the point would be to attach a pressure gauge to the coil and so secure an actual experiment. Even then I doubt very much whether an ordinary pressure gauge would indicate any change of pressure, for the reason that while the water in the coil itself would increase, it is possible that the increase in cubic capacity of the coil would exceed the expansion of the water and in such a case, there would be no increase of pressure. Under any circumstances, there would be no danger of bursting the coil, since its elasticity would be sufficient to take up all the pressure due to the expansion of the water.

Silver City, N. M. E. L.

Answer to Question of F. C., Toronto, Can., in December Issue.

EDITOR THE PRACTICAL ENGINEER:

Your explanation of ammeter readings in connection with the alternating current question of F. C. in the December issue is misleading, as in dealing with alternators, the "primary" voltage must be taken into account. In practice it is sometimes 1000 or 2000 volts or even higher. In all probability, the 115 volts was the secondary voltage after being transformed from the higher voltage. Then 25 amperes at 1000 volts would be an output of 25 kilowatts or 500 ordinary 16 candle power lamps, or, if the primary voltage of the alternator was 2000 volts, this kilowatt output would be doubled.

In practice, I have always found it is a good idea to start up a machine that is connected to idle lines, so as to let the voltage of the idle lines build up very slowly with the increased speed, as by this method, if linemen are at work on idle lines, they have one chance to know that the lines are rapidly becoming charged, even though the insulation on the wires may be full strength. It is a fact almost universally known that an alternating current of high voltage makes its presence known through induction. In other words, you can "feel" that the wire is charged by simply placing the hand on the outside of the insulation. The wire "feels" as if it is vibrating, due to the alternating and inductive effects of this class of current.

I simply mention this latter fact as it may be of interest to some of your readers.

St. Louis, Mo. G. S. N.

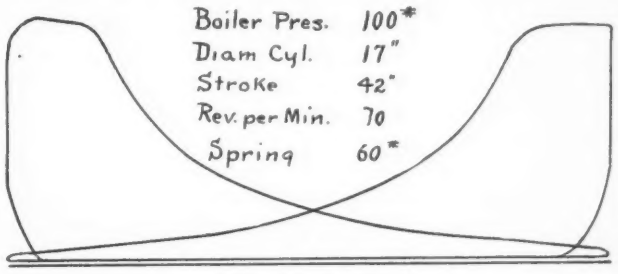
Could these Indicator Cards be Improved?

EDITOR THE PRACTICAL ENGINEER:

I would like to have your readers' opinion on the enclosed indicator card. It was taken from a Vilter Corliss engine direct connected to a 13" x 26" ammonia compressor. The size of the engine is 17" x 42", steam pressure 100 pounds, revolutions 70 per minute and scale of spring 60. Could I improve this card? How?

What is the horse power developed by the engine?

Texarkana, Texas. J. E. S.



Corliss Engine Cards.

The horse power of the engine taken from the card is found to be 103.8, which is divided almost exactly between the two ends.—[Ed.]

Receiver Pressure for Compound Engines.

EDITOR THE PRACTICAL ENGINEER:

What should be the receiver pressure in a Tandem Compound engine 14½" x 28"? The pressure in the high pressure cylinder is 135 pounds, what should be the pressure in the low?

Phila., Pa. R. T.

The receiver pressure in an engine should never be more than half the boiler pressure. How much less it should be depends upon the size of the engine cylinders and the cut-off, so as to obtain an equal distribution of work in each cylinder. There is considerable latitude allowable for adapting the pressure in the receiver to the demands of the low pressure cylinder without considerably diminishing the effective work of the engine.

The reason for this is as follows: Supposing there was not any loss of heat between the cylinders, it is plain that any steam that passes through the high pressure cylinder must also pass through the low. By varying the cut-off in the low pressure cylinder and therefore the volume of steam admitted for each stroke, the steam will go into it at a higher pressure and less volume or at a lower pressure and greater volume; the pressure and density of the steam adjusting themselves to suit the volume that the steam is permitted to occupy in the low pressure cylinder. With a short cut-off in the low pressure cylinder, the pressure in the receiver can be kept at the exhaust pressure of the high, but with a later cut-off, the pressure in the receiver may drop to three-fourths of the pressure of the exhaust steam from the high, or even less.

If it is desirable to have the same power exerted in each cylinder, the receiver pressure to obtain it can best be found practically by taking cards on each cylinder and calculating the horse power. The receiver pressure can then be raised or lowered by regulating the valves in whatever respect is shown to be necessary by the card.—[Ed.]

Electrical Problems.

EDITOR THE PRACTICAL ENGINEER:

Kindly answer the following questions:

(1). What is an automatic circuit breaker and how does it work?

(2). What does a two-phase 7200 alternations inductor type generator mean?

(3). What is an exciter?

(4). What is a synchronous motor?

Bridgeport, Conn. H. C. T.

(1). An automatic circuit breaker is an arrangement interposed in an electric circuit usually for the purpose of opening the circuit in case the current rises above a prescribed amount, thus protecting all apparatus from harm.

In its general form, it consists of a handle to which the contacts are fastened so that when the handle is thrown in its usual position, contact is made with the line wires, but when the current becomes excessive, the handle is drawn away from the switch by the action of a spring, thus breaking the circuit. When everything is all right in the circuit, the handle is held in place against the action of the spring by a trigger. If the current gets too great, a coil of wire in the shape of a helix, through which the current passes, draws up a movable iron plunger which hits the trigger and sets the handle free to be opened by the spring.

(2). As an alternation is a change in the current of a circuit from zero to maximum to zero or from zero to minimum back to zero, alternating current machines are rated according to the number of alternations which they make in one minute. Thus, a machine going 7200 alternations means that the current passes through zero 7200 times every minute.

An alternator can be arranged to give a single pressure wave over a two-wire circuit in which case it is called a single-phase machine and the current in the circuit is called a single-phase current. Some machines are arranged to give pressure to two distinct circuits, each of which considered alone is a single-phase circuit. In this case, the machine is said to be a two-phase generator.

An inductor generator is one in which both the armature and field coils are stationary. The moving part of the machine carries no wire, but has pairs of soft iron projections called inductors. These projections are magnetized by the current in field coil. As the inductors revolve, they set up an electromotive in the armature which varies from maximum to minimum, depending on the position of the inductors in reference to the internal projecting armature cores.

(3). An exciter is nothing more than a direct current generator which is used to excite the fields of an alternating current machine.

(4). Any excited single-phase or polyphase generator, if brought up to speed, will operate as a motor if connected to an electro-motive force of the same frequency and approximately the same voltage. The motor is then so linked with the frequency of the circuit that the exact speed will be maintained throughout wide ranges of load. This speed is called the synchronous speed and the motor is therefore called a synchronous motor.—[Ed.]

Location of Brushes on the Armature.

EDITOR THE PRACTICAL ENGINEER:

In the station that I am running I have a direct current machine that will generate only when brushes are set as in Fig. 1. I would like to set the brushes as shown in Fig. 2. What must I change to make it generate that way? I have put the current through the fields in different ways but that would not work. As a motor it will run with brushes set as shown in Fig. 2, but it will not generate. Kindly give me instructions through the columns of "The Practical Engineer."

Eau Claire, Wis. T. W. P.

The proper position of the brushes of any dynamo depends upon the winding of the armature and its connections. It is usual to place them so that the maximum difference of potential is available. On many types of two pole machines this would put the correct position for the brushes when the dynamo is operating under load as shown in Fig. 1 in the accompanying sketch. If the brushes are moved around from this position the number of volts available diminish until when at 90 degrees from the normal position, as shown in Fig. 2, no volts at all can be generated. If the machine were separately excited it would show very bad sparking in this position.

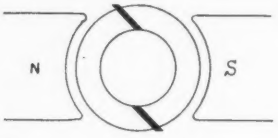


Fig. 1.

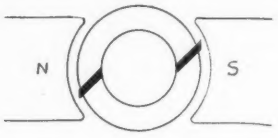


Fig. 2.

The only way to fix the machine so that it could be used with the brushes as shown in Fig. 2 would be to unsolder all the connections going out to the commutator and splice out the wire ends so that instead of each pair of ends coming into the bar where it is now found, it is carried around to meet the bar 90 degrees from its present position. This produces a result the same as would be had if these connecting leads to the commutator bars were rubber bands and the commutator was simply moved through 90 degrees of rotation.

The reason the machine manages to run as a motor with the brushes set as in Fig. 2 is simply because while before each pole the direction of current in some of the conductors on the armature is such as to pull one way, while that in other conductors is to pull the other way, there is just enough overbalance to produce rotation in a certain direction. This would be true most likely no matter whether the machine were separately excited or whether the machine were to develop its own field by some slight armature reaction, assuming, of course, that the motor has no load on it.—[Ed.]

Wire for Demagnetizer.

EDITOR THE PRACTICAL ENGINEER:

Please give dimensions and size of wire of a watch demagnetizer to operate on a 100 volt circuit. Will it work on either direct or alternating current?

Anaconda, Mont. C. H. P.

A demagnetizer will only work on an alternating current circuit. Any kind of wire, wound in a hollow spool, will answer for a demagnetizing coil. Practical men who work in power houses often revolve their watch between two alternating current wires, which is sufficient to demagnetize it. If it is desirable to make a demagnetizing coil which will operate on a 100 volt circuit without interposing any resistance, a certain size wire must be selected, its safe carrying capacity found and then its required length to give the resistance necessary to keep the current within limits must be calculated. According to this method it is found that 4000 feet of No. 12 wire will answer the purpose or 5000 feet of No. 16 copper wire. The placing of resistance in the circuit would obviously be less expensive. An incandescent lamp gives a large resistance and if connected in series with a small coil of wire, it will cut the current down to below one-half an ampere so that as much or as little wire of almost any size could be used on the coil.—[Ed.]

Carrying Capacity of Wire. Horse Power of Boiler.

EDITOR THE PRACTICAL ENGINEER:

(1). Will you please give me a table of the carrying capacity of electric light wire by number for incandescent lighting; also how to figure the power required for incandescent lights at 16 candle power each?

(2). How do you figure out the rated horse power of a tubular boiler 72 inches diameter by 18 feet long with 72 4-inch flues?

Wells, Mich. W. B.

(1). The carrying capacity of electric light wire by number giving the safe current and maximum number of 16 candle power lamps is as follows:

Size of Wire.	Safe Current in Amperes.	Max. Number of 16 C. P. Lamps.
0000	175	350
000	145	290
00	120	240
0	100	200
1	85	170
2	70	140
3	60	120
4	50	100
5	45	90
6	35	70
7	30	60
8	25	50
9	22	44
10	20	40
12	15	30
14	10	20
16	5	10
18	4	8
20	2	4

An incandescent lamp usually requires 3.5 watts per candle power, so that a 16 candle power lamp will consume 56 watts. Since there are 746 watts in one horse power, one horse power should approximately furnish 13 lamps of 16 candle power each.

(2). In figuring out the rated horse power of a boiler from the heating surface it is usual to allow 11.5 square feet of heating surface per horse power. This value is based on the assumption that 3 pounds of water will be evaporated from and at 212° per square foot of heating surface per hour.

The heating surface of a horizontal tubular boiler is assumed to consist of two-thirds of the circumference of the shell, two-thirds of both end sheets, less the area of the tubes or flues and all of the interior of the tubes or flues. From the above data this gives:

Shell .....$2\text{-}3 \times 18 \times 3.1416 \times (72 \div 12) =$ 226.2
Heads ..$2 \times 2\text{-}3 \times (0.7854 \times 72 \times 72 \div 144) =$ 37.7
Tubes .....$72 \times 18 \times 3.1416 \times 4 \div 12 =$ 1357.2

Total = 1621.1
Less area of tube holes = 12.6

Total heating surface = 1608.5

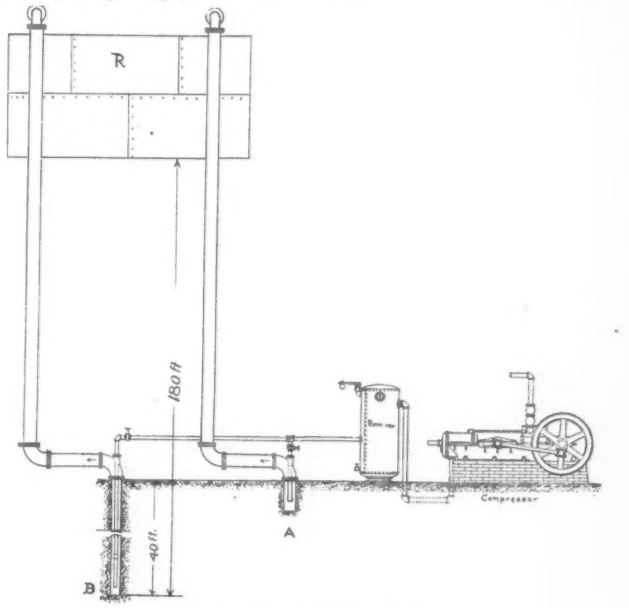
Allowing 11.5 square feet of heating surface per horse power, this will give by dividing 1608.5, the total heating surface by 11.5, 139.8 horse power or approximately 140 horse power.—[Ed.]

A Pump Problem.

EDITOR THE PRACTICAL ENGINEER:

Will you kindly give me the following information through the columns of your valuable paper? The accompanying sketch will give the necessary data:

Will it be practical and economical to pump water at B with a pump driven near A? A is a flowing well or spring and furnishes about 150 barrels per hour. It is forty feet above B. B is an artesian well and furnishes water for city mains. R is the reservoir and 180 feet above B. The object is to catch the overflow of the artesian well during the day time while our municipal lighting plant is shut down. F. S.



Arrangement for Lifting Water.

A pump could not be used as shown in your sketch because it is not practical to obtain a suction of more than 15 or 20 feet. While water can be forced almost any distance on account of its being incompressible, it cannot be held in much

tension as the particles of water will not adhere to each other, thus preventing its continuity of flow.

The arrangement shown in sketch would work if in the place of a suction pump, an air compressor be used. The compressed air will force the water out of the artesian well to any height desirable. This is the most favored method used to utilize artesian well water as the source of supply is often hundreds of feet below the surface of the earth.—[Ed.]

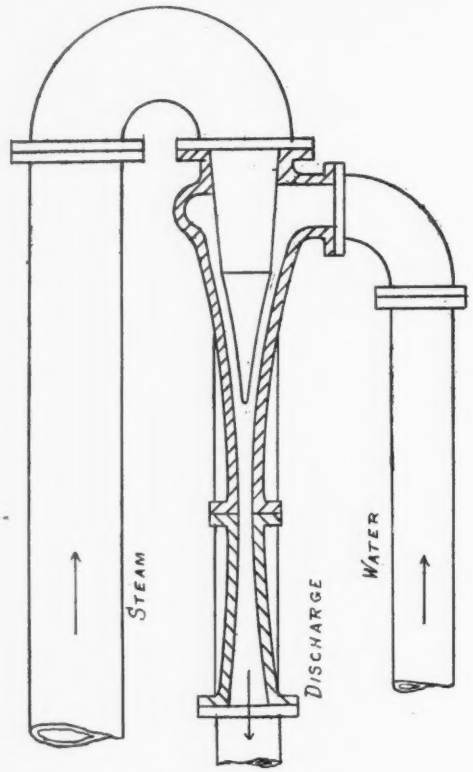
The Barometric Condenser.

EDITOR THE PRACTICAL ENGINEER:

Will you please illustrate and describe the barometric condenser, stating its advantages over surface and jet types?

Depew, N. Y. W. D. C.

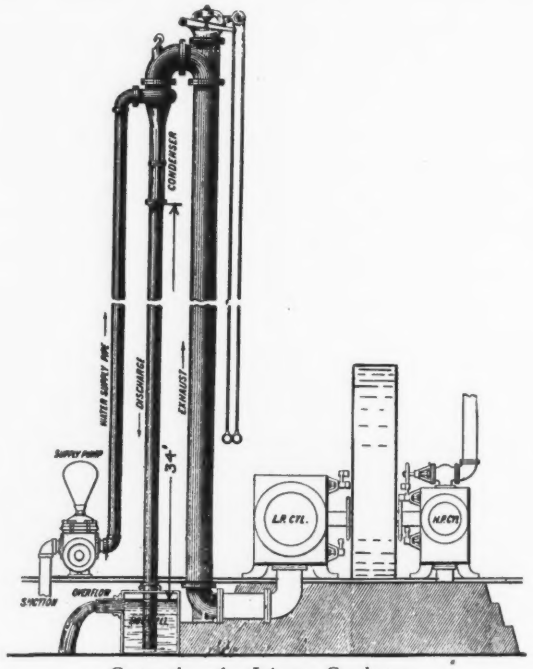
The barometric condenser depends upon the principle that the pressure of the atmosphere will balance a column of water 34 feet high in a vacuum. If then a sealed tube, say 36 feet high, is filled at the open end and the end immersed under water, there will be a water column supported whose height will approximate 34 feet and the upper part of the tube above the water will contain a vacuum. If more water were allowed to run into the tube, it would have no effect on the level in the tube, the water level being maintained so long as the vacuum is not broken by the admission of the atmosphere. If steam



Injector Condenser.

be admitted to the vacuum above the water and then condensed, it can readily be seen that the vacuum will be maintained.

The arrangement for doing this in practice is known as the barometric condenser, as shown in Fig. 1. Fig. 2 shows the arrangement of piping for its successful operation. The condenser should be placed about 34 feet above the level of the hot well, and the discharge pipe, leading from the condenser to the hot well, must always have its end immersed below the level of the water in the well.



Connections for Injector Condenser.

The exhaust steam from the engine takes a downward direction as it enters the condenser and passes through an inner cone which is surrounded by cold water pumped into it by the supply pump. As the steam becomes condensed and falls to the lower part of the cone it mingles with the condensing water. The condenser is narrow at the centre in order to create a high velocity of the discharge water, because on account of air leaks which destroy the vacuum, it is advisable to draw it through the cone with the mixture. After having passed the contracted neck, the air and vapor enter the tapering nozzle and expanding therein are prevented from returning to the vacuum which is being continually formed above. The exhaust pipe is usually equipped with a relief valve in case the pressure in the condenser from any cause should rise above the atmospheric pressure.

The principal advantages of the barometric condenser over other types are its lower first cost and lower cost of maintenance. The only apparatus necessary to produce the vacuum which requires steam is the supply pump and even this can be done away with if the supply water is led to the condenser under a head. The supply pump need only be large enough to handle the condensing water and if the water flows to the pump by gravity, centrifugal or rotary pumps can be used.—[Ed.]

Fluctuation of Water in Boiler.

EDITOR THE PRACTICAL ENGINEER:

(1). What causes the water to rise and fall in a water glass on a low pressure heating boiler? Of course, some may not, but in most cases it is very hard to say how much water is in the boiler.

(2). Is it possible to set an air valve for any number of pounds, say three or five? It has always been my way to set one when steam was blowing through and just close it gently so when the pressure was off it would contract and when steam came up again it would expand and close itself.

Boston, Mass. F. H. R.

(1). The rise and fall of water in a water glass is primarily due to the ebullition of the water in the boiler. In a low pressure heating boiler, this fluctuation usually becomes very apparent because very often on account of the rapid consumption of steam by the radiators, the boiler does not generate steam so fast as it is being used, the effect of which is to drive the steam through the pipes in impulses. This often, momentarily at least, leaves the surface of the water in a partial vacuum which causes the water to rise rapidly, which rapidly increases the pressure again and the water level is lowered. After the pressure gauge shows several pounds pressure and all the radiators are hot, unless the boiler is too small for the system, the surging of the water level should not be so great.

(2). Since all air valves depend upon expansion to work their moving parts, they are dependent upon the temperature rather than upon the pressure. If a valve could be set to close when the pressure was three or five pounds, there would be a waste of steam through it until it reached that pressure and as the heating value of steam at one pound pressure and steam at five pounds is practically the same, it is impossible to see what advantage would be derived by such a valve.

Your method of procedure of adjusting the air valve is the correct one.—[Ed.]

Heating Surface in Boilers for Petroleum.

EDITOR THE PRACTICAL ENGINEER:

Will you please answer the following:

What is the difference, if any, in the number of square feet of heating surface per horse power allowable in a boiler when firing with coal and when firing with petroleum?

Oil Centre, Cal. E. C.

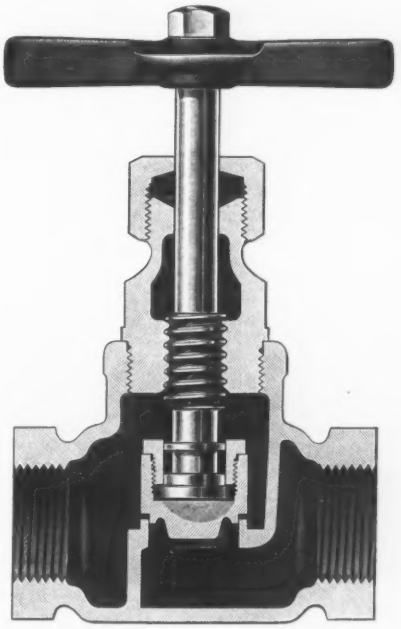
The designer of a boiler must consider several important factors when designing a boiler for a certain horse power. He must not only be sure that it evaporates the required number of pounds of water per hour, but he must allow a sufficient surface for heating the water without making the boiler too large or too expensive. Hence, conditions are such that the results of practice have shown that for maximum economy with any kind of fuel, one square foot of heating surface should be given for every three pounds of water evaporated from and at 212° per hour.

This applies to petroleum as well as good coal, although poor fuel would require a greater amount of heating surface. As a boiler could be forced to greater extent with petroleum than with coal, a greater horse power could be obtained from a given boiler by using petroleum, but as the heating surfaces are only capable of transferring a certain amount of heat in a certain time, any attempt to force them means a decrease in the economy of fuel burnt, as the temperature of the flue gases is then too high. This effect becomes more aggravated when the surfaces of the tubes become coated with scale on one side and with dirt and soot on the other.

It is therefore usual for maximum economy, to allow the same amount of heating surface per horse power independent of the fuel used.—[Ed.]

The Hancock Valves.

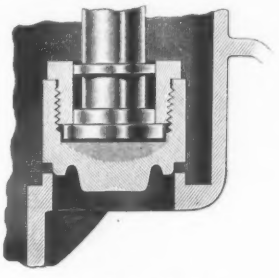
The Hancock valves herewith illustrated are made of the screwed and flanged type up to 3 inches and are made in the Globe, Angle, 60° and Cross form. The special composition of which they are made was designed to give great strength and resistance to wear and under actual test the bodies are said to



Hancock Valve.

stand a pressure of 4000 pounds per square inch, and remain tight with a water pressure of over 1000 pounds per square inch.

In order that the valve seat may be hard and durable, the body is made of a hard and tough mixture and the discs are made of a special mixture which does not contain any zinc. The valve spindles are made of Tobin bronze, which, when working in the special composition bonnet, will not cut under the highest steam pressure.

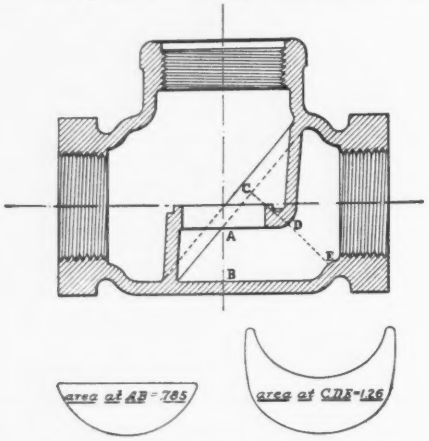


Valve Seat and Disc.

The valve is guided on its stem by two collars or guides which guide the disc nut, thereby causing the disc to seat squarely and preventing the disc from cocking. The seat of the valve is flat. The disc has a projection on it which serves two purposes. In the first place it acts as a guide when the seat is ground, and in the second place, this lip or projection on the disc prevents the cutting of the seat by wire drawing of the steam when the valve is cracked or slightly open.

When the valve is slightly raised from its seat, as shown in the illustration, with its lip entering slightly, it allows the escaping steam to clean the seat, so that when the valve is seated dirt and foreign matter is washed or blown off the seat. This is an important feature as experience has shown that when the valve does begin to leak, it requires very little regrinding to make it tight.

The bonnets of these valves are made with a long thread engaging the body of the valve, the shoulder on the bonnet being made narrow so that by this narrow seat on the shoulder it is possible to keep the bonnet tight, and when it is desired to



Cross Section of Valve showing Available Steam Areas.

unscrew the bonnet, it can be easily done. When it is necessary to regrind the valve to its seat the bonnet is removed, the disc nut unscrewed from the disc and a piece of wood can be inserted in the disc enabling it to be ground perfectly as the projection on the disc guides it, it not being necessary to have any special regrinding tools.

The tee handle is efficient in opening and closing them, and all these valves are equipped with these handles. The accompanying illustration shows the method of attaching the tee handle. The hole in the handle is made tapering with one side

Handle and Spindle.

flat. The spindle of the valve is also made tapering with one side flattened to receive the handle, the tee handle being held on the spindle by means of a nut. The flattened side holds the handle in place and the taper enables the handle to be drawn tightly to the spindle.

The Hancock Valves are made by the Hancock Inspirator Co., whose general office and salesroom is at 85 Liberty Street, New York, with a branch office at 22 S. Canal Street, Chicago, Ill., and whose factory is at Boston, Mass. They guarantee that every valve has been tested with 1000 pounds water pressure and found tight before it is allowed to leave the works, and is guaranteed for 500 pounds steam pressure.

———o———

The Lubron Pump Valve.

There are few things in the average power plant that cause more annoyance to the engineer than the giving out of pump valves, and that efforts are being constantly made to improve them is only natural when it is considered what expensive results sometimes accompany the shutting down of a pump.

A new valve designed to prevent these difficulties is being placed upon the market by the Lubron Mfg. Co., 88 Broad St., Boston, Mass., for which its manufacturers make very strong claims. The points of superiority claimed for the valve are that it is made from a patented composition possessing great wearing qualities and that it is not affected by either heat or cold, steam, hot water, brine, ammonia, oil, gasoline, benzine or other similar substances, and that it works equally well under either high or low pressure, in a noiseless manner. The valve has a slight flexibility which prevents all leakage where conditions are imperfect. After a six months' test a full equipment of these valves was recently installed in the plant of the New England Telephone and Telegraph Co.'s building in Boston.

Lubron Valve.

The Lubron Company feel so confident of the merits of their valve that they will send one free to engineers requesting same, if they give the size wanted and the pressure on the pump on which it is to be used.

———o———

Book Review.

Smoke Prevention and Fuel Economy, by Wm. H. Booth and J. B. C. Kershaw. Size 5½ by 8½. 194 pages and 75 illustrations. The Norman W. Henley Publishing Co., 132 Nassau St., New York. Price, $2.50.

The contents of this book may be briefly said to contain an account of the chemistry of the combustion process, a description of the present methods of burning coal, improved methods of burning fuel, methods of examination of the waste gases and the control of the combustion process. The appendix includes abstracts of English, German and American patents and tables of fuel analyses, losses and costs.

The book, while containing nothing that is new, is written in a clear, comprehensive manner. The chapter on the chemistry of the combustion process does not involve anything that cannot be easily understood, as the use of complex chemical symbols is avoided. The chapter on the present methods of

burning coals describes the difficulties which are encountered in the fire boxes of boilers as they are usually built to-day. The chapter on improved methods of burning fuels describes a number of grates and furnaces which have recently been designed to perfect combustion. One of the best chapters in the book is that which explains how to examine the flue gases from a boiler and how to obtain from the examination indications as to whether the proper conditions are being maintained in the fire-box.

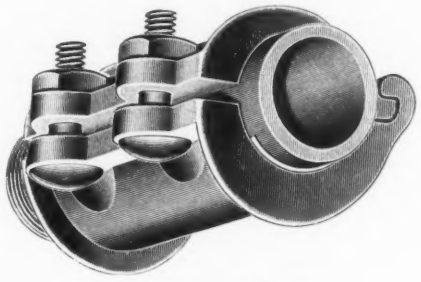
———o———

Emergency Pipe Clamp.

As a result of many inquiries in reference to repairing leaks and splits in pipes, James McCrea & Co., of 63 W. Washington Ave., Chicago, Ill., have just put on the market the Emergency Pipe Clamp which fulfils this purpose. This Company has for years been manufacturing the Climax Steam Joint Clamp and have therefore had a great many calls for an arrangement that would repair leaky pipes.

The accompanying illustration represents one of the Pipe Clamps in position on a pipe. It is made of malleable iron and is furnished complete with packing ready for use. The arrangement consists of two portions, hinged on one side and clamped together with two bolts on the other, it being strongly ribbed in the centre so as to obtain a uniform pressure throughout its length when pressure is put upon the bolts.

Should a pipe for any reason become split or leaky other than at the joints, all that is necessary is to place one of these



Emergency Pipe Clamp.

clamps over the leaks and tighten the bolts. The packing fills in the leaks by the pressure and the whole arrangement makes a very satisfactory repair.

They are made in all sizes for pipes from one-half inch to four inches in diameter and they vary in length from 3¼ inches for a one-half inch pipe clamp to 6 inches for the four-inch. They were designed to be used in cases of emergency and as they can be attached in a moment, the use of them may often save valuable property. As they are not expensive, all the sizes can be laid in stock at very little cost.

———o———

Quaker City Auxiliary.

Quaker City Auxiliary, No. 3, N. A. S. E., held a "Fruit Party" Saturday evening, November 19th, at their rooms, N. E. Cor. Eighth and Spring Garden Streets, Philadelphia.

Entertainment was furnished by Miss Mae McLaughlin, pianist and contralto; Mr. A. P. McHugh, of Jenkins Bros., baritone; Miss Alberta May Carless, recitations; Mr. Wm. D. Mahn, of the Walsh Packing Co., bass solos; Mr. Ed. Britt, coon songs, and last but not least, Mr. Jas. D. Kelly, of the O. F. Zurn Co., who acted as auctioneer with great success.

After the baskets of fruit had all been sold, the fun began. The auctioneer invited the successful bidders to hunt the lady who donated the basket and whose name was found inside of the package. In a few minutes the room presented the appearance of an old-time "Harvest-home" gathering, after which Mrs. Irvin Lee, President of the Auxiliary, outlined the objects of the Auxiliary, and invited those eligible to join.

The Auxiliary is at present in a flourishing condition, and gives promise of many such enjoyable affairs during the coming season. The committe on this occasion consisted of Mrs. Enoch Carless, Chairman; Mrs. Wm. Schofield, Secretary; Mrs. John T. Gaskill, Treasurer; and Bros. Chas. W. Snyder and G. F. Duemler.

The meetings of Quaker City Auxiliary are held every third Saturday of each month, at their hall, N. E. Cor. Eighth and Spring Garden Streets. The officers for the present year consist of the following sisters: President, Mrs. Irvin Lee; Vice-President, Mrs. L. H. Fletcher; Treasurer, Mrs. Wm. J. Glenn; Secretary, Mrs. Richard Pape; Conductor, Mrs. Eb. Carless; Doorkeeper, Miss Lizzie Drager; and Chaplain, Mrs. Enoch Carless.

———o———

A Swell Job.

An engineer of our acquaintance was recently engaged to fill the position of engineer in a hospital just outside of Philadelphia. When entering upon his duties the first morning, he was handed a letter of instructions, a copy of which we print below, omitting only the names:

September 17, 1904.

Mr.————————

Dear Sir: The position for which you have applied at the ———— ———— Hospital embraces the following duties:

The care and operating of the engine, boiler and machinery in the laundry; assistance in handling the heavier laundry work.

Care of the heaters in the Hospital and Nurses' Cottage.

Supervision of the drains and such cleaning of them and pumping as may be necessary to keep them open and operative.

Disposing in manner required of the garbage and rubbish.

Keeping the driveway and walks in Hospital ground in good order.

Helping when needed to move or carry any patient.

The person occupying this position will be required to be on duty every day from 7.00 o'clock in the morning until 6.00 o'clock at night, with an hour for dinner, and such times earlier and later than these hours as special matters may require. On Sundays he must devote as much time as the work requires to the care of heaters in all buildings and must use care and judgment in firing and keeping clean all fires so as to economize on coal and keep the fire-places clean.

The pay will be Forty-five Dollars ($45.00) per month and the incumbent will board and lodge himself and must live within a quarter of a mile of the Hospital.

Yours very truly,

————————

TRADE NOTES

EDITED BY THE ADVERTISING MANAGER

In future, this department of The Practical Engineer will be edited by ME. I'm the Ad. Manager, so if there are any criticisms—or compliments, almost forgot the compliments—just send them to the Ad. Manager in big letters. I always like to see my title in big letters; it makes me feel important, and you all know what a nice feeling that is. A man may seem important to others, or he may even be important, without getting much out of it, but to FEEL important is to enjoy one's own existence.

The Editor—God bless him!—won't permit me to "break in" anywhere else in the paper, so I'll have my say here, and if any of you boys who chuck in your "fifties" to pay the Editor's salary, and write him so many nice letters, want to be charitable, you'll help me out, for heaven knows I'll need it. Whenever you catch me going up the wrong street, call me down. I'll stand for it, honest I will, and I'll be much obliged, too. Then when you happen to know something to tickle the fellows who pay MY salary, the ones who buy up big chunks of The Practical Engineer for the purpose of getting acquainted with YOU, just drop them a line and tell them about it, and tell them that you did it for the sake of The Practical Engineer; charge the postage to me, I'll pay it, sure I will, and then when they get orders they will buy more space, and I will get more salary, and you will get more paper—a bigger one and a better one, if that's possible, and we will need more assistant editors, and some of you boys will get the jobs, and then you will know more about an editor's troubles. See? I'm commencing to feel like an editor already.

I've been reading the letters from engineers about opening and closing valves. The Editor tells me he has received a thousand letters on that subject, and they are still coming. I saw him go out just now with a bunch of letters in each coat pocket. If he doesn't come back, it will be up to some of you fellows to write a fitting epitaph. The whole thing has gotten me so badly twisted that when I saw a man opening an oyster the other day I asked him if he ever "used a wrench on them."

Speaking of valves reminds me, I was in New York the other day, and it was cold as blazes, so I went into The Hancock Inspirator Co.'s office, at 85 Liberty street, to warm my feet, you know. While I was there they decided they couldn't get along without an ad. in this issue. Then I began to get interested. They told me very confidentially that they had something brand new and of special interest to engineers. You can imagine the shock when they brought out a valve. I thought they were going to tell me how to open and close it, but they didn't, so I heaved a sigh of relief as they explained its construction and its advantages for high pressures. They might as well have thrown water on a duck, for I was busy thinking about how much space I could sell them, but I recall that they showed me a nice new catalogue showing cuts and descriptive matter pertaining to the valve, and told me to say they will send it to any engineer who wants one. It looked worth writing for, too.

The first piece of mail matter received by me after getting my official commission as Trade Note Editor is a new calendar for 1905 issued by A. W. Harris Oil Co., Providence, R. I. Its size is 9x5 inches, and it is printed in several colors, with a handsome illustration at the top. The Harris Co. are noted for their liberalities, and they will send you one if you drop them a card and tell them that The Practical Engineer said so.

Engineers generally will be interested to know that the patent litigation between the Sterling Lubricator Co., of Rochester, N. Y., and Green, Tweed & Co., of New York city, has been finally settled. The matter, which has been in litigation for nearly five years, has been vigorously contested and very expensive to all concerned. The suit involved certain patents of a force feed lubricator owned by the Sterling Lubricator Co., of Rochester, N. Y. Green, Tweed & Co., who claimed that this lubricator was an infringement upon certain patents held by them, brought suits against users of the Sterling Lubricator, and also applied for, and in 1903 got, an injunction against the Sterling Co. During the past month the Circuit Court of Appeals reversed the previous decision, thus giving the victory to the Sterling Co. The decision applies by stipulation to the other cases in which the users of Sterling Lubricators were involved and in which the Sterling Co. were furnishing the defense. Those who have purchased lubricators are therefore no longer in danger of being drawn into the affair. The immediate result of the settlement will doubtless be a boom in the business of the Sterling Co., who are already preparing to increase their facilities on a large scale.

A gold medal has been awarded to the Harrison Safety Boiler Works, Philadelphia, Pa., for their Cochrane Feed Water Heaters and Purifiers, shown in the exhibit of the Philippine Government Board at the Louisiana Purchase Exposition at St. Louis. Another gold medal has been awarded for the general exhibit of the Cochrane Heaters, the Sorge-Cochrane Systems (for the thorough heating and purification of water for boiler feed and other purposes) and the Cochrane Steam and Oil Separators. The Harrison Safety Boiler Works may justly feel gratified by the distinction of receiving the only two gold medals that were awarded for feed water heaters, combined heaters and purification systems, and separators.

The November Bulletin published by the Kutztown Foundry & Machine Co., 116 North Broad street, Philadelphia, is devoted exclusively to grate bars of the Tupper and other standard types. It will interest engineers generally. A copy will be mailed free upon request.

Robert T. Mickle, M. E., announces that Mickle-Milnor Engineering Co., Drexel Building, Philadelphia, have succeeded to his business as representative of H. R. Heinicke, Inc., designers and builders of hollow brick chimneys, and Herron & Bury Mfg. Co., air compressors.

Mr. M. T. Davidson, of 141 Broadway, New York city, has within the last few months received a number of letters in reference to the Davidson Pump which should be very gratifying to him. These letters come from the proprietors and heads of hotels or establishments in which the Davidson Pumps have been installed, and above their signature they say that not only does this pump give entire satisfaction for elevator service, but when tested it has been shown to be far more economical than the ordinary type of pump.

Mullin's Automatic Controller for Boiler Feed Pumps obviates the necessity of the heretofore almost constant hand regulation of the throttle valve of the boiler feed pump. It has no arms, weights, springs or floats, but by a simple arrangement of putting the steam pressure on one face and the water pressure on the reduced area of the opposite face, a water pressure is maintained in excess of the steam pressure, absolutely without regard to fluctuations of the steam pressure.

The Federal Valve Co., 2534 Western avenue, Seattle, Wash., will be pleased to send a circular or explain the actions of this interesting device to any reader of The Practical Engineer.

"Practical Questions and Answers" to prepare for engineer's license is a little book which is sent free to engineers by Thos. C. Warley & Co., manufacturers of Warley's Boiler Compounds, 221 South Front street, Philadelphia.

Jas. McCrea & Co., 63 West Washington street, Chicago, Ill., manufacture a clamp for stopping leaks in steam pipe joints which never fails to effect a cure and costs much less than tearing out a section of pipe, especially in cold weather, when it doesn't pay

to cut out the line. It's a good thing to have a few of these clamps on hand.

The Lubron Mfg. Co., who have been for many years at 38 India street, Boston, Mass., have recently taken new quarters in the Broad Street Exchange Building, at 88 Broad street, near their old address, where they have an attractive suite of offices fitted up. They have recently begun the manufacture of a new pump valve described on another page of this issue, and a gauge glass reflector which will be illustrated later.

Messrs. Adam Cook's Sons, 313 West street, New York city, recently received a letter from W. W. Bennett, superintendent of agencies, Pope Motor Car Co., Toledo factory, which states: "We have used considerable Albany Grease at this factory, and it has proven very satisfactory; in fact, we cannot recommend it too highly.

The handsomest Packing catalogue that has come to our notice has just arrived from the Garlock Packing Co., of Palmyra, N. Y. It contains 136 pages and nearly as many illustrations. It is printed on the finest grade of coated paper, and the handsome new cuts are so well executed that an engineer could easily comprehend them even if there was no descriptive matter in connection with them. In addition to packings for every variety of service, this catalogue describes numerous other engine room specialties, all of interest to readers of The Practical Engineer. A copy will be mailed to any engineer mentioning this journal.

The Kruger & Blind Co., 511 and 513 Master street, Philadelphia, are running their shops to their fullest capacity. Their engine repair business has grown wonderfully during the past year, and they are employing a larger force of skilled mechanics than ever before. They are also installing a complete new plant of 150 h. p. capacity.

Engineers who are interested in indicators should write to Jas. L. Robertson & Sons, 205 Fulton street, New York, for a copy of their catalogue. The Improved Robertson-Thompson Indicator is a most excellent instrument and is sold at a very moderate price.

If you want the genuine Moncrief Scotch Gauge Glasses, write to H. A. Rogers Co., 19 John street, New York city.

Mr. D. W. Patterson, Eastern sales agent for the Chaplin-Fulton Mfg. Co., manufacturers of the Vigilant Feed Water Regulator, has moved his Boston office from 30 Oliver street to 141 Milk street. Mr. Edwin A. Knowlton is manager of the Boston office. In addition to the Vigilant Feed Water Regulators, Mr. Knowlton is the New England representative for the Bordo Company.

LIBRARY MAY 25 1905 (Free)

The Baum Separator and Machine Co., Manheim, Pa., have published a new catalogue which describes and illustrates Baum Separators in an attractive manner. The construction is shown down to the most minute detail, and it gives sizes, capacities and prices, all of which every engineer should know. It is printed in colors on good paper, contains 28 pages and cover, size 6 inches by 9 inches. A copy will be sent upon receipt of postal card request.

This is the season when preparation is being made for next summer's ice supply; new plants are being contemplated or in course of construction, and many new machines will be installed during the next few months. Readers of The Practical Engineer who are interested in refrigerating machinery should write to the Frick Co., Waynesboro, Franklin Co., Pa., for a copy of their handsome ice machine catalogue.

JUST WHAT YOU NEED,

A New Book on Injectors. Their Construction Care and Management, 84 Pages, 45 Engravings, 16 Tables, By Frederick Keppy, M. E. I will send you a copy of this valuable Book on receipt of 25 cents in postage stamps.

F. KEPPY
108 Park Street, Bridgeport, Conn.

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How to run Engines and Boilers

A book that is full of information for firemen and engineers. It tells what you want to know in a plain practical way that is remembered.

$1.00 post paid

The Slide Valve

Explained simply and clearly. Brought up to the latest American practices. There is a real use for it in every up-to-date engine room.

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A set of 6 large plates to detail with descriptive matter of a high speed steam engine and centrifugal governor. 50 cents

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Publishers of Books for Engineers
Dept. P. E., Liberty Bldg., New York, U.S.A.

January "Graphite"

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COPIES FREE

JOSEPH DIXON CRUCIBLE CO.
Jersey City, N. J.

Cochrane Separators
YOU OUGHT TO HAVE THEM

Separating water from steam or oil from steam is dependent upon precisely the same principle, i. e., that of removing liquids from gaseous or vaporous currents. But while you might get along with a separator that takes out only half of the water you would soon get into trouble with this 50 per cent. efficient separator for oil service, and the separator that is adapted for oil service is the separator that will give you the best results in live steam service, the construction being adapted for the higher pressures. The Cochrane Oil Separators gave such exceedingly efficient and satisfactory results in taking out oil that we knew they would make good steam separators, and they have. The Cochrane Separators will take care of a flush of water, the opportunity is given for the water to flow right straight into the well, any water (or oil) shot along by the steam over the main opening to the well is intercepted by the baffle, the ribs on the baffle prevent side travel, the ports are on the side and properly placed, the steam passages are of the right size, altogether the separator represents the minimum loss from friction. Liberal storage space is provided for, and the water that is taken out is prevented from being picked up again by the current of steam. As to workmanship, materials, fittings, they are the best.

If you would like to know more about these Cochrane Separators send for our catalogue 16-S. Yours for the asking.

HARRISON SAFETY BOILER WORKS
3144 N. 17th Street, PHILADELPHIA, PA.
Manufacturers of Cochrane Feed Water Heaters, Cochrane Steam and Oil Separators and the Sorge-Cochrane Systems.

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WE DON'T WANT ONE DOLLAR OF YOUR MONEY

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We make a specialty of the hardest and most difficult cases of scaly boilers, and use none but the purest and highest grade of Chemicals in the manufacture of our Compounds. An absolute guarantee given on each package to every new customer.

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We will impart the secret to you. They are higher priced and very much better than the ordinary kind for all *HARD-TO-FILL* places.

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Power Plants inspected with view of suggesting changes and improvements to reduce operating expenses and increase efficiency.

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Indicator with Reducing Wheel.

A complete Indicating outfit.

We also make the Thompson Damper and Pressure Regulator, the latest.

The Soot Ejector, the one that cleans the tubes, and Grate Bars to burn coal.

Send for Catalog.

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A Word to Wise Engineers

QUAKER CITY RUBBER CO.
Philadelphia, Pa.

Gentlemen:

We have this day, Oct. 4th, 1904, packed the piston rod of our shop engine with P. P. P., and for the first time since Christmas of 1902, twenty months and nine days of continuous running (except a shut-down of two weeks); and from three to four months of this time has been thirteen hours a day. The remainder of the time, engine has run full days. For months at a stretch no attention was given to the packing, and its action was perfect.

PARIS FDY. & MACHINE WORKS.
Per B. R. Simmons.

Why continue to fret, sweat, and keep your fingers burnt, through the use of common rod packing? The above letter is food for thought. Think of the labor P. P. P. saved the engineer by permitting him to forget the stuffing box for nearly two years. Think of the decreased consumption of steam, coal, and packing. When you can save all this work and money, its your duty to

USE P. P. P.

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The Quaker City Rubber Co. Philadelphia.

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Smoke and Spark Preventer
For Stationary Boilers

Patented March, 1902, in United States and Foreign Countries

Prevents smoke and sparks, whatever kind of coal is used.

Insures perfect combustion, consuming all gases, thereby securing highest economy possible.

Increases the capacity of any boiler, while saving labor and fuel.

Can be readily installed in all forms of boilers and boiler settings.

NO MOVING MECHANISM NO STEAM USED NO POWER USED

NO EXPERIMENT, it being in actual successful commercial use.

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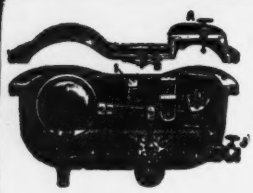

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REDUCING VALVES
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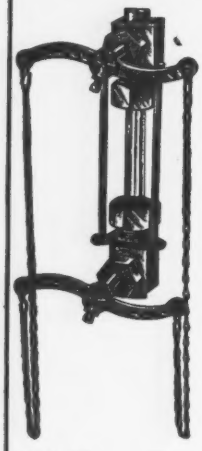

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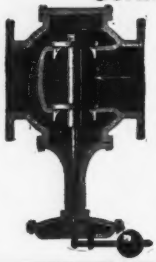

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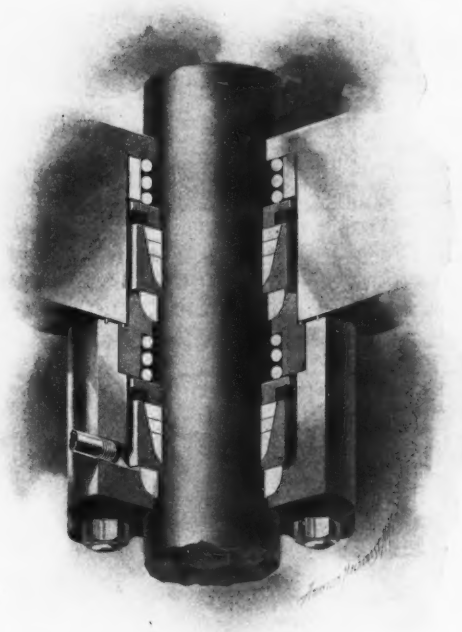

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Piston Rod and Valve Stem
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GOLD MEDAL
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DAILY WASTE ACCOUNT IN THE
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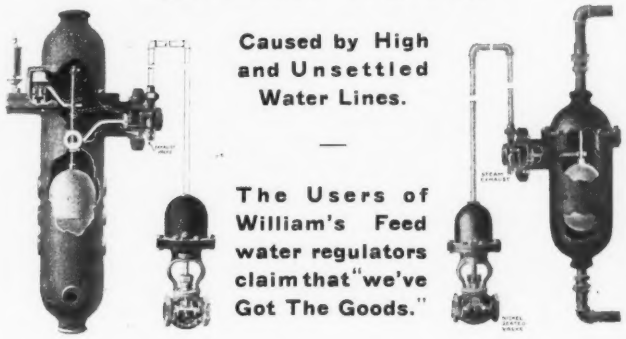

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Pays for original investment about twice yearly.

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from exhaust pipes is a nuisance, an expense, and an eye-sore.

THE STERLING EXHAUST HEAD

will clear the atmosphere of the water and grease, your mind from annoyance, your walls and roofs from rotting, and your future from the possibility of a law suit from a slippery side-walk.

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This Device is so constructed that it adjusts itself to variations in diameter of Tubes, thoroughly cleans all spots, does not catch on its withdrawal, and effectually overrides all uneven surfaces. This Cleaner will not loose its temper by using it in hot Tubes and is just as efficient for hot or cold Tubes.

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The only information necessary to send is, pipe connection in bearing, depth of oil hole from top of cap to journal, and give particular part of machinery on which the same is to be tested.

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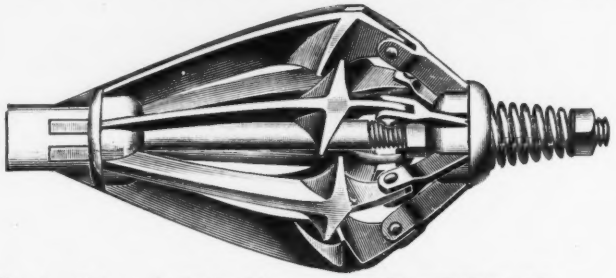

Has six self sharpening blades doing perfect work, and in spliced flues

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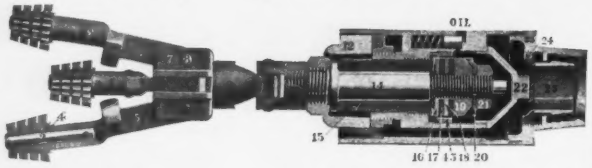
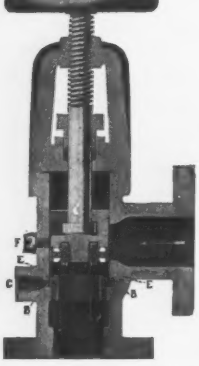
Reading, Pa.

The "Liberty" Hydraulic Tube Cleaner



Thoroughly cleans more Tubes in **less** time and at **less** cost of LABOR and REPAIRS than it is possible to accomplish by the use of ANY OTHER CLEANING DEVICE.



GIVE US A CHANCE and we will prove this statement as we have proven it in hundreds of other cases.

The "Faber" Blow-off Valve

Does not leak, because a Steam Jet blows away all sediment from the Seat and Disc just before the Valve closes.

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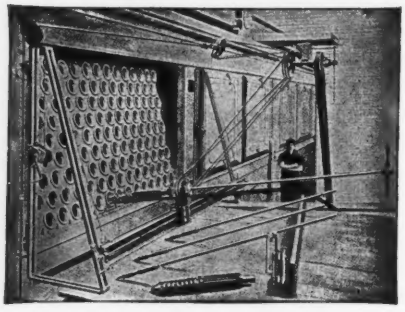
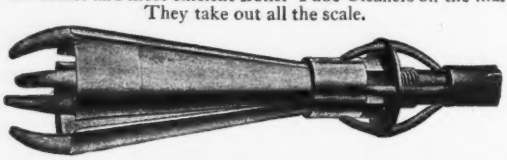


The Union Boiler Tube Cleaners

POWER OR IMPULSE

Are the oldest and most efficient Boiler Tube Cleaners on the market. They take out all the scale.



The Gem Flue Scraper does the same for Smoke Flue Boilers

We also make **Gem Oilers,** Patent or Plain, **Torches and Heavy Brazed Steel Oilers, Flexible Shafting, Loose Pulley Lubricator.**

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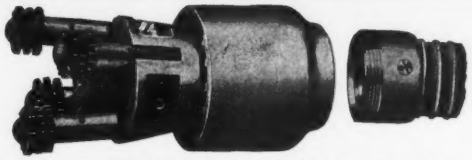
For "Boiler Surgery"



The worst cases of scale can be operated upon successfully with

Weinland Tube Cleaners.

Water drives the machine and a steady grinding process cuts the scale from the iron without expanding, loosening or injuring tubes in any way.

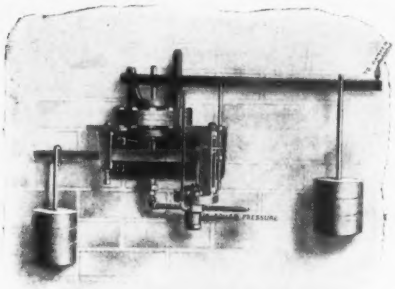
They have restored thousands of boilers to perfect condition, and what they have done for others they'll do for you. This cut shows our No. 8—THE KING OF TURBINE CLEANERS, besides which we manufacture others—Hand Cleaners and Power Driven Cleaners—all kinds and sizes for all styles of boilers and all sizes of tubes. "No Tube Cleaner Like a WEINLAND"—Anybody who's used one will tell you that.

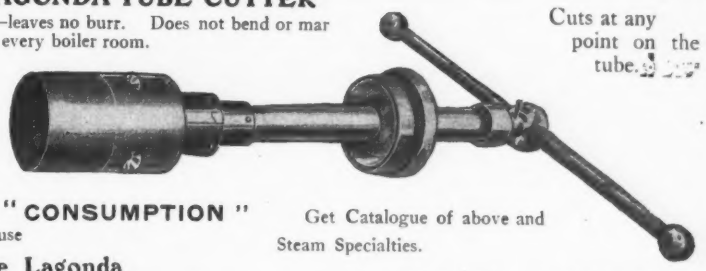
We do contract cleaning, if you want it that way.

For "AMPUTATING" Tubes use THE LAGONDA TUBE CUTTER

It does the work quickly, easily, and cuts clean everytime—leaves no burr. Does not bend or mar the tube in any way. A simple, inexpensive tool needed in every boiler room.

Cuts at any point on the tube.





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The Lagonda Damper Regulator

It absolutely controls damper in stack on the slightest variation of steam.

Get Catalogue of above and Steam Specialties.

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Boiler Cleaning Experts—at it 20 Years.

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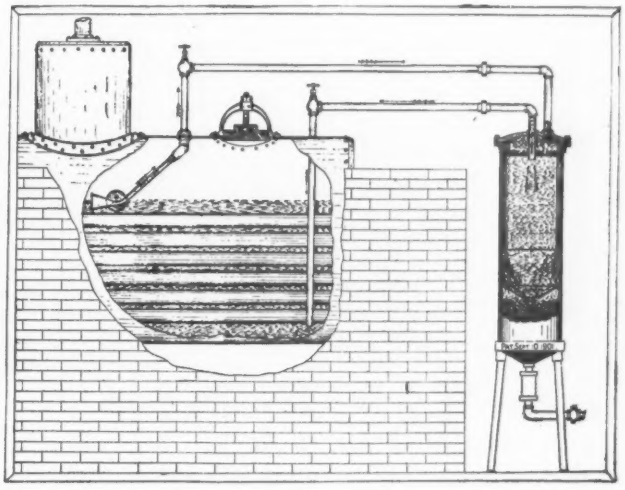
"SHE'S A DANDY!" Said He.

AND THE BEST I HAVE YET SEEN

This was the exclamation of a prominent engineer the other day as he stepped back after examining one of his boilers upon which he had been testing

THE BUCKEYE AUTOMATIC BOILER CLEANER

Then he fished up a stub of a lead pencil and took the president of his company over to the little desk in the corner. In black and white he showed the president that the cost of equipping the entire plant with Buckeye Automatic Cleaners would be less than cost of a years supply of boiler compound, and said he, there will be no chemicals to injure the iron and moreover, the Buckeye Cleaner will last for years and cost nothing to maintain. Its only another case of producing economical results by the use of Automatic machinery. The president agreed and the boilers are being equipped by



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We install them on trial
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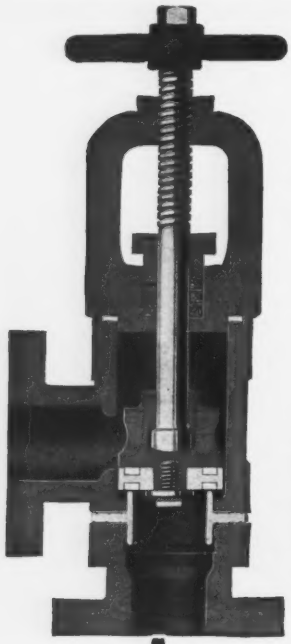

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Any engineer can make two valves out of one if that one is a Cadman. The seats and discs are reversible. When either or both become worn, reverse them and you have a new valve. And this without removing the body from its position. Here's a chance to save time, work and money. Grasp it today by writing for particulars.

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Commence a new era by using Sterling Boiler Compound, a product of the twentieth century. It is the most effective and least injurious on the market, a new boiler compound of wonderful power, manufactured in powder form and unlike any other dry or liquid compound. It is entirely free from acids and therefore will not injure valves, valve discs, gum joints, rivet heads or other boiler fittings. It will prevent pitting, corrosion and the formation of new scale, and will soften old scale so that it can be readily washed out. Sterling Boiler Compound will not harden in the barrel. It is readily dissolved in warm water.

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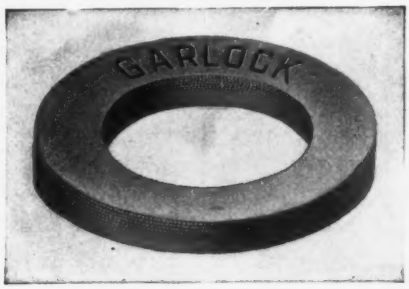

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No. 260—Garlock solid ring packing for pump cylinders and inside packed plungers. This is a most disagreeable and annoying place to pack, and every engineer will appreciate this packing for its durability.

This packing has been used many years and is the only packing that will give satisfaction on boiling water and high pressure.

If you are interested we will send you a *sample set free.* Sizes must be exact.

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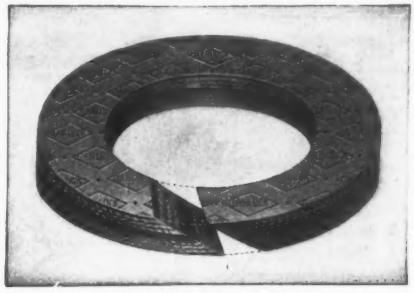

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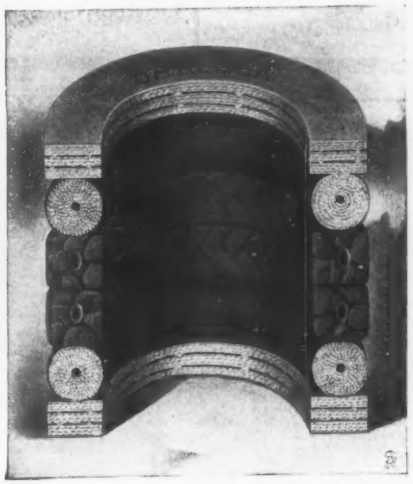

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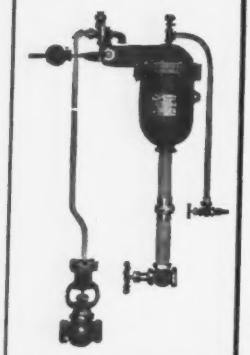

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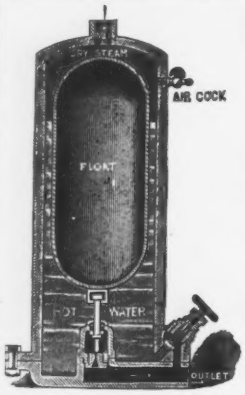

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If that old trap is wasting steam and not doing its work, replace it with the H. H. STEAM TRAP, and have no more trouble or expense.

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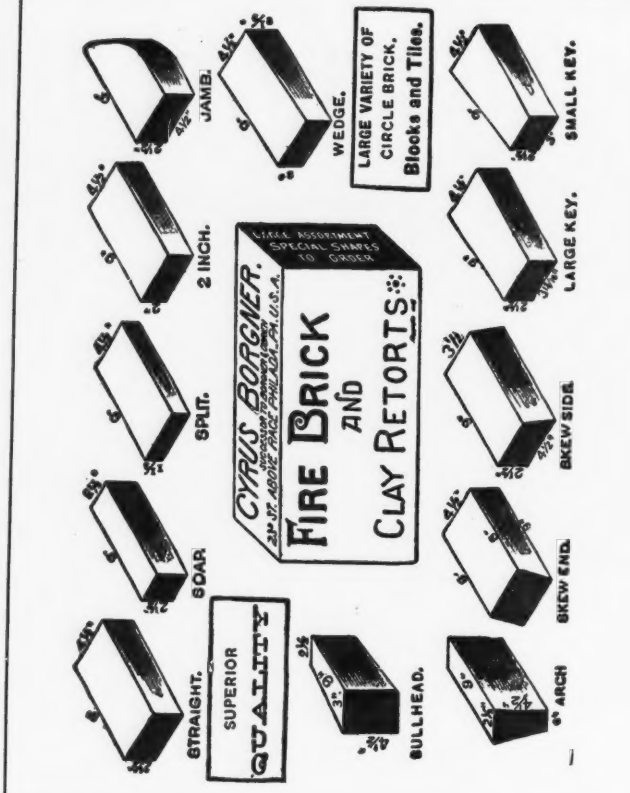

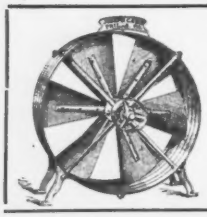

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Will stand any pressure and outlast Three ordinary Valves.

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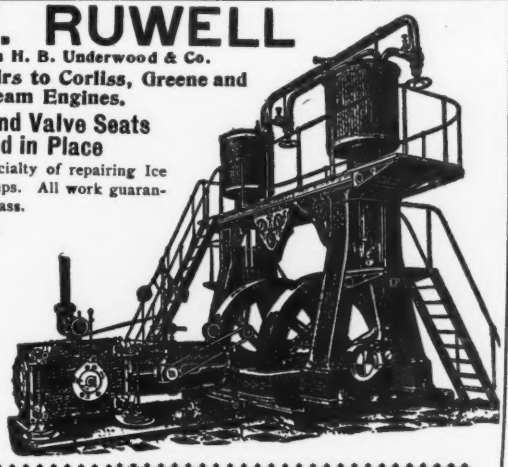

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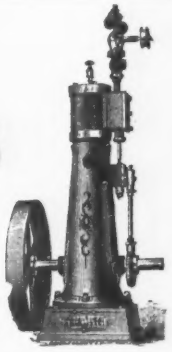

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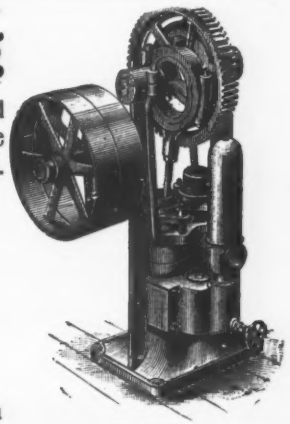

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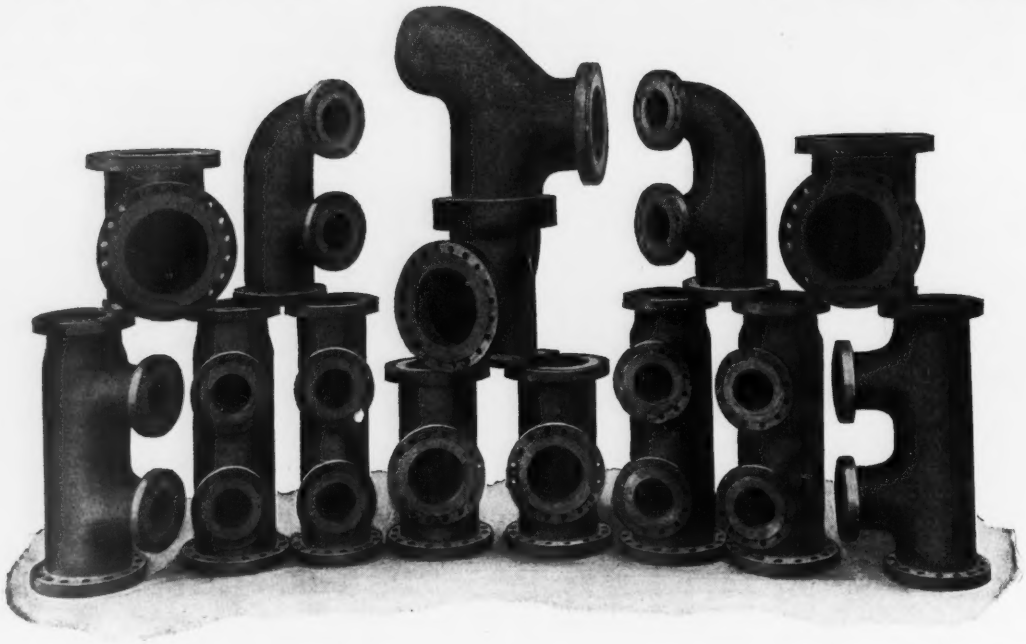

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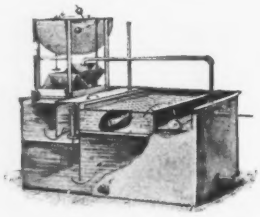

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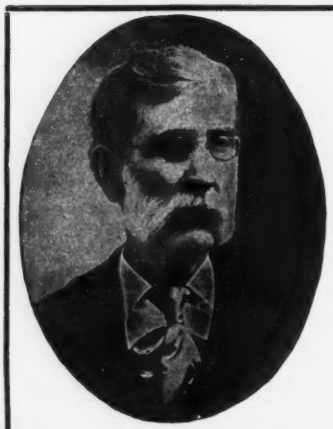
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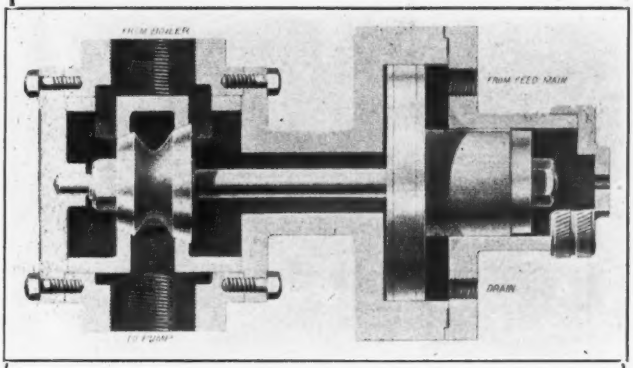

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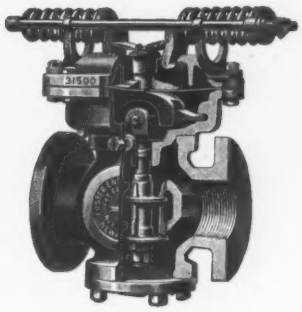

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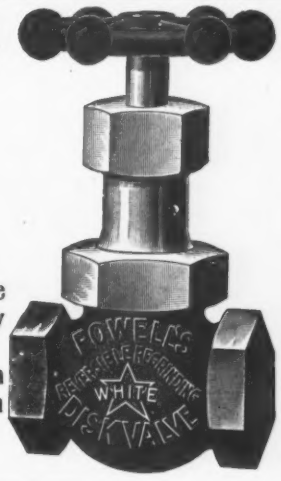

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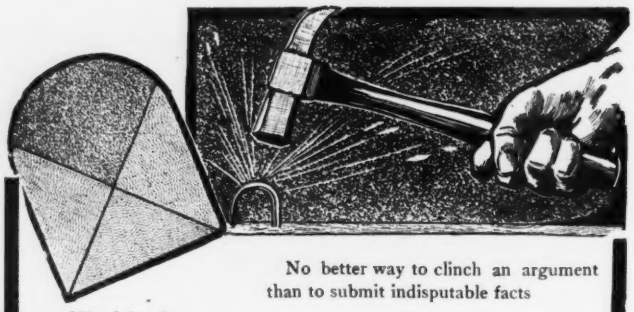

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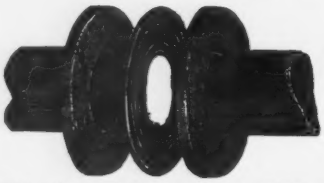

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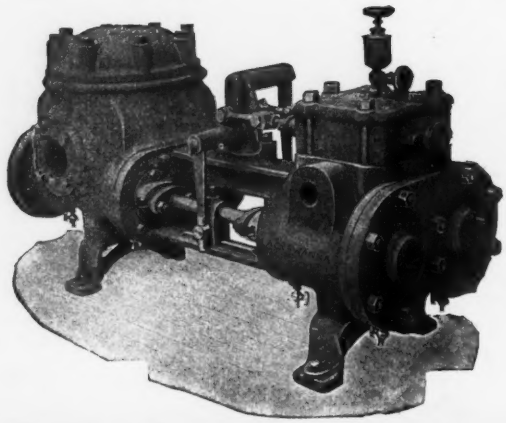

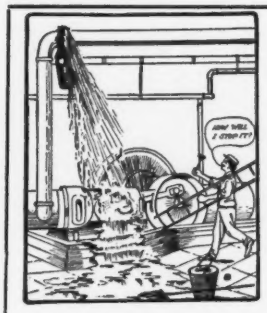

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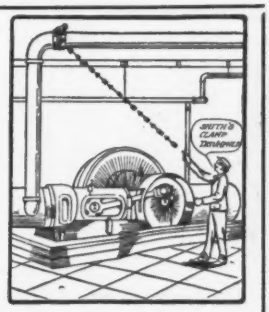

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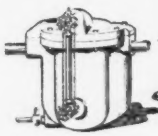
Simple Trap is The Wright "Emergency" Steam Trap



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Removing an iron plug with a wrench, and the valve seats by means of a screw-driver, does the work.

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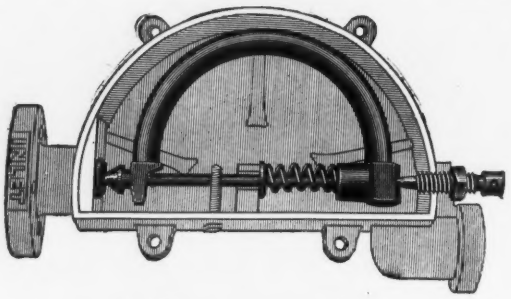

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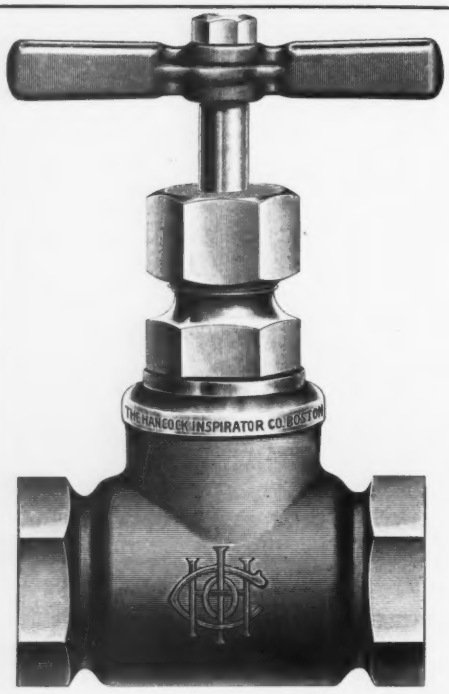

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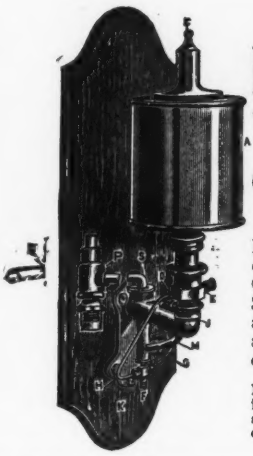

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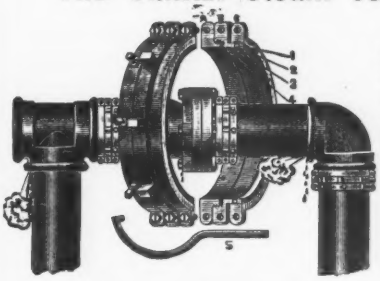

Operates on the same principle as a gland and stuffing box. The packing being confined is forced to the leak without crowding out between face of fitting and face of clamp. You cannot make a permanent repair unless clamp has containing ring.

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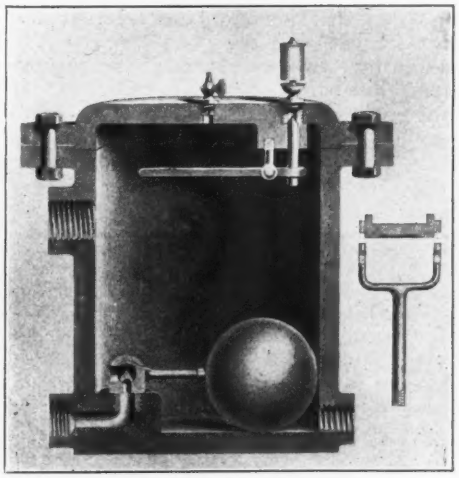

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Kindly send them forward as soon as possible. This is the only Trap we have ever seen that is worthy of the name.

Very truly yours,
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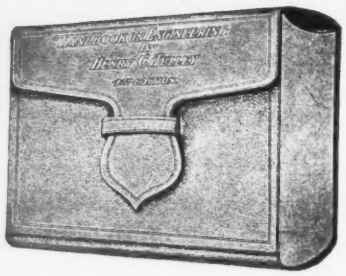

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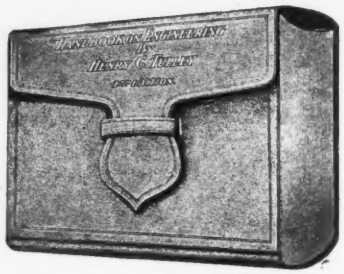

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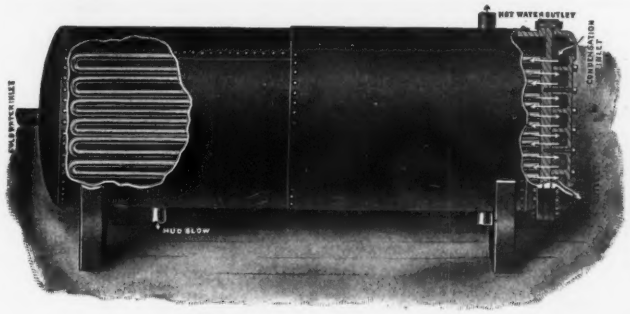

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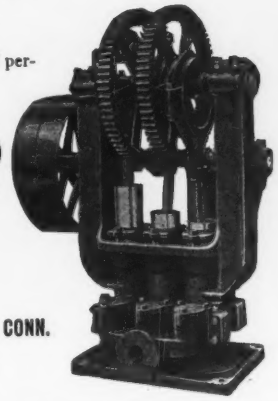

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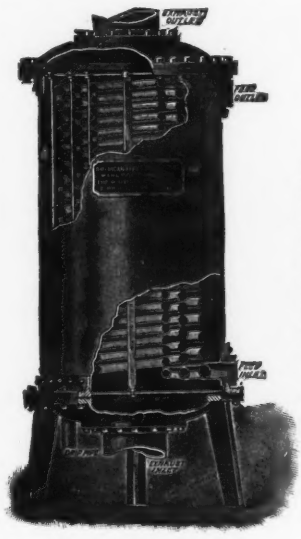

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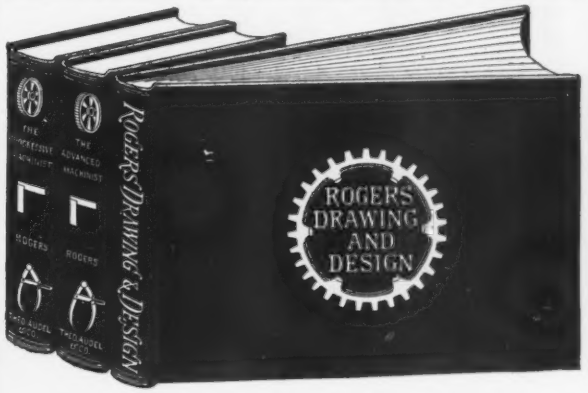

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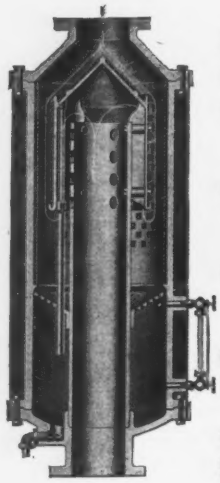

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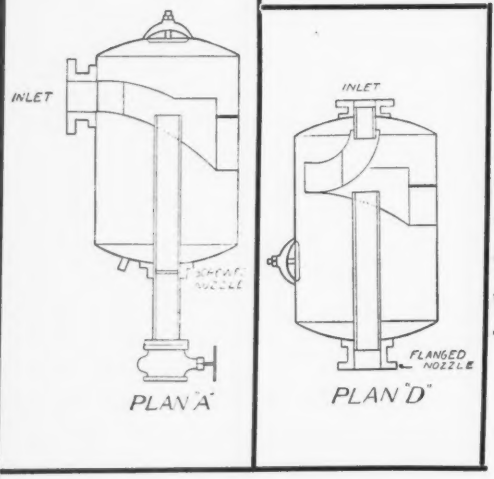

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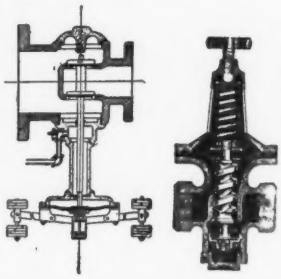

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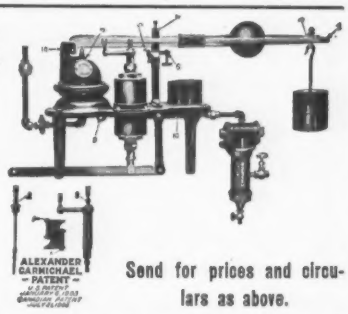

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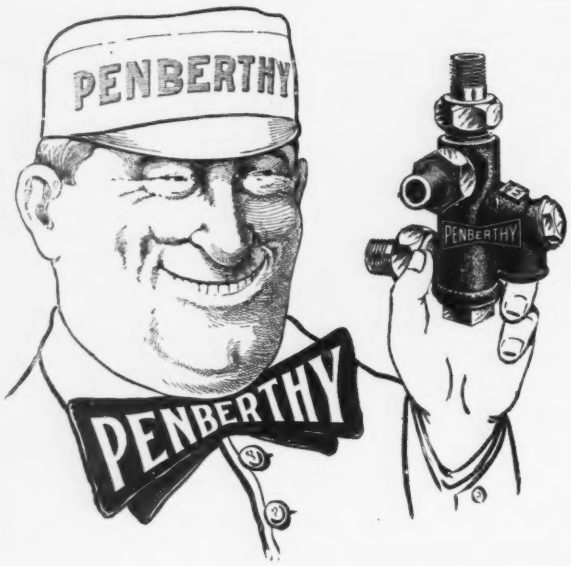

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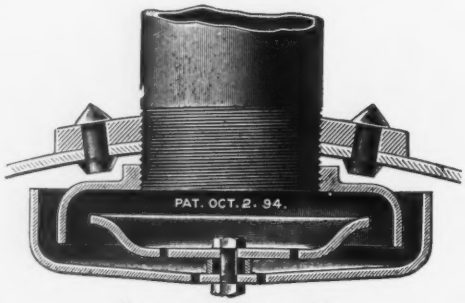

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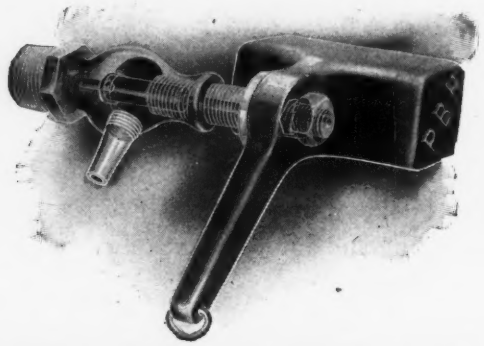

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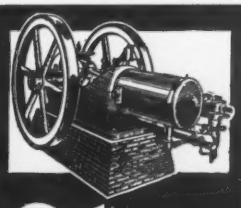

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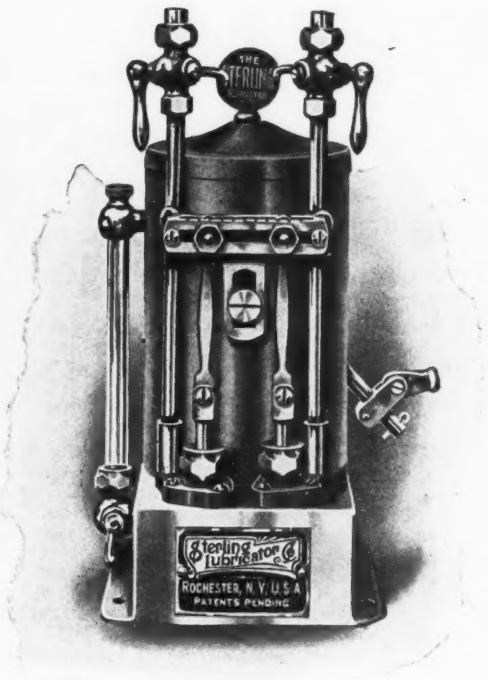

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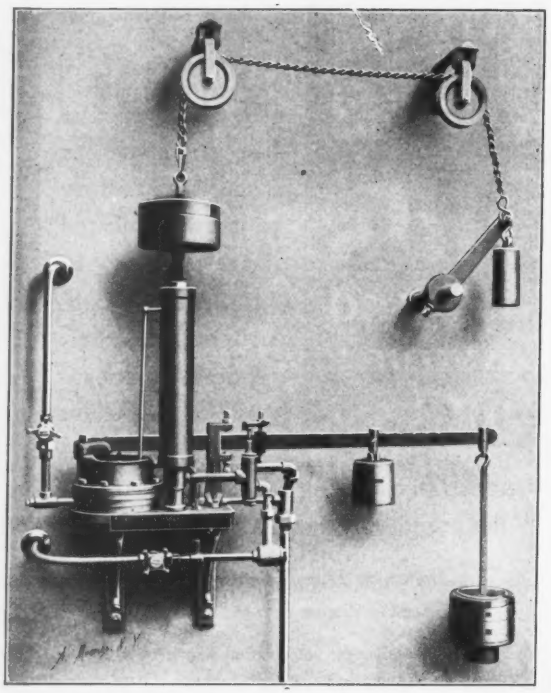

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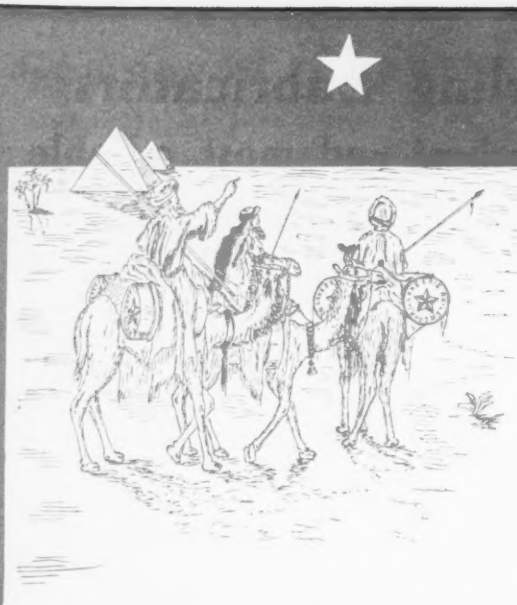

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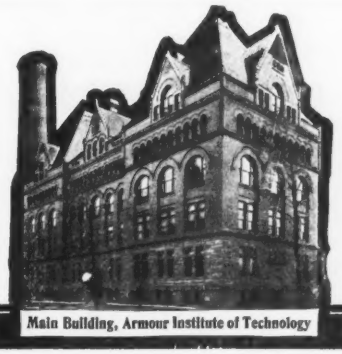

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You know whether or not you need a technical education.

You know that men who have attained success have had an education of some sort. And you know that a good many of these men have hewed out that education for themselves without going to College.

Every man doesn't have a chance to go to College.

But every man has a chance to make the best of his opportunities.

We can't give you a College education, but we can give you the next best thing to it.

We can help you master many of the hard problems which stand in the way of your success, and we can help you lay a foundation of good, sound, common-sense information (technical knowledge) which every man must have if he is going to get ahead in his work.

There are a good many general in the army who rose from the ranks and who never went to West Point. And they didn't get ahead from Luck. They got ahead because they put in their spare time mastering the problems of their profession. They didn't have a personal instructor to help them over the hard places; they had to work out their own salvation.

Lincoln never went to College. Edison never had a technical education except what he gleaned from stray books. These men fought a hard battle and won.

And it was harder to get ahead then than it is now.

If you had an authority at your elbow, to consult with every day, at your work, think how fast you would learn and how quickly you would get ahead.

If you had a chance to ask all the questions you wanted to about your work:—how best to accomplish certain results; how to make quick repairs; how to "figure out" problems; how to make a drawing that would express that good idea you have thought of so long; how to save waste energy in the shop; how to save time and delays and the money that's thrown away every day in just this way—you would feel inclined to look into the matter, wouldn't you?

Well—that's just what we are offering you—an authority or a dozen authorities to consult on just these things.

You work under the personal direction of the members of the teaching staff of a great technical school—Armour Institute of Technology.

You can carry your class-room (your instruction paper) around in your pocket. You can read it at home, you can study it on the street car going to work, you can get a chance to look into it at noon-hour. And it won't be long before you will realize the benefits in your pay envelope. It won't be long before you may have a chance to be foreman, or superintendent, or start a small plant of your own.

The future is full of opportunities for the man who is ready for them.,

You want to be that man.

The course you want may be anyone of those listed below. What we have said applies to all of them. All we want is that you let us tell you more about what we can do for you. You can do it best by tearing out and mailing us the coupon, telling us what your work is, what you want to do and checking the course you are interested in. DO IT NOW.

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CHICAGO, ILL.

I am interested in the course of instruction which I have marked below.

My work is.....

I want to become a.....

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Engineers' Course, for license.	Boiler Makers' Course.	Architecture.
Firemen's Course, for license.	Tool Makers' Course.	Architectural Drawing.
Electrical Engineering.	Tinsmithing.	Textile Manufacture.
Power Station Work.	Marine Engineering.	Mechanical Drawing.
Electric Lighting.	Locomotive Engineering.	Perspective Drawing.
Telephone Practice.	Refrigeration.	Mathematics.
The Electric Telegraph.	Civil Engineering.	Navigation.
Electric Wiring.	Railroad Engineering.	College Preparatory. (Preparing for entrance to resident Engineering Colleges.)
Mechanical Engineering.	Hydraulics.	
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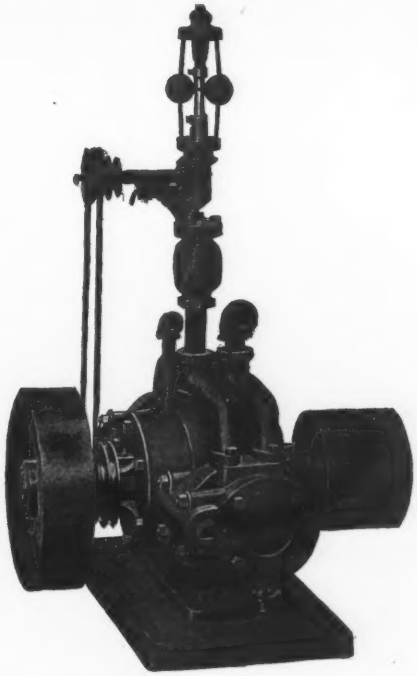

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Look at it. Read about it and think about it; perhaps there is a place about your establishment where you can place one to advantage.

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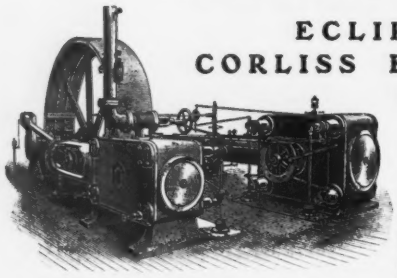

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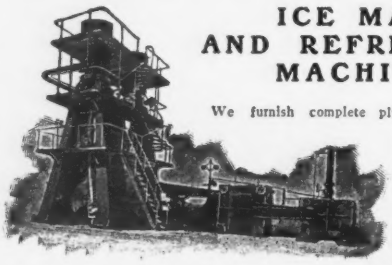

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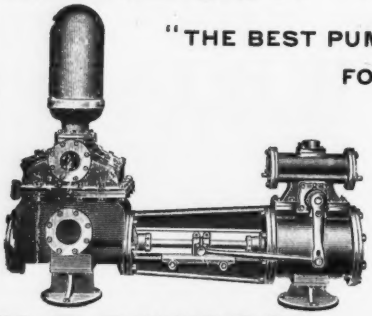

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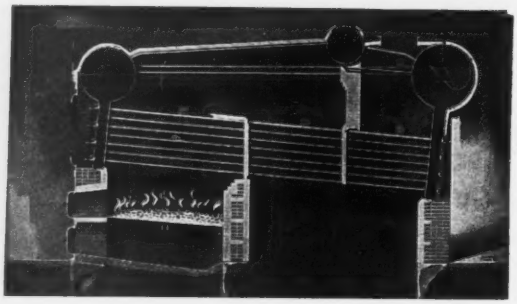

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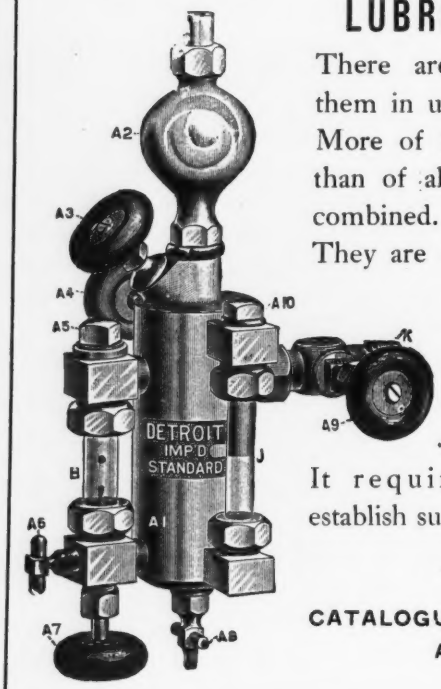

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They are used by fully nine-tenths of the prominent American engine builders.

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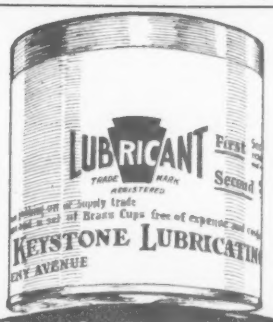
We will send FREE a large sample can and a heavy grease cup to any engineer sending us his name and business address.



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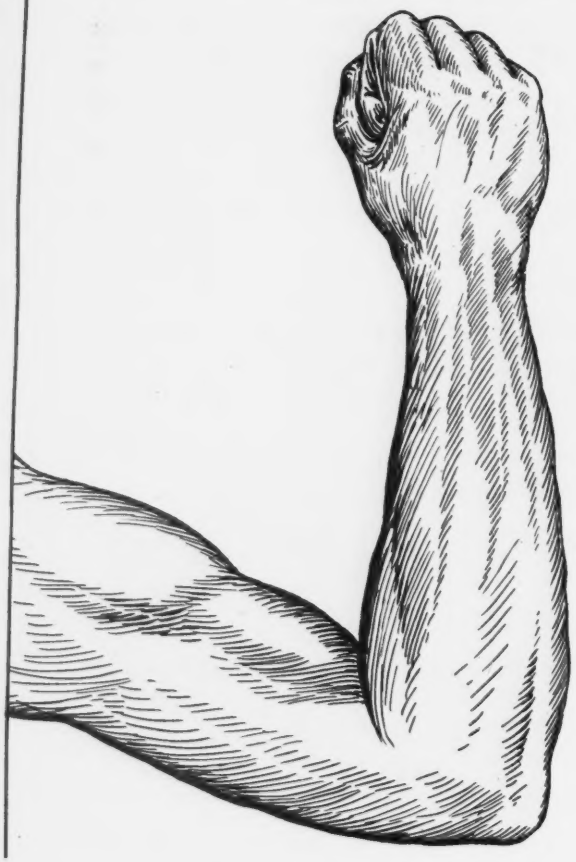

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that steam or hot water pipes which are insufficiently protected are the agencies through which a great deal of good valuable fuel is wasted. That they are often the direct cause of accidents, and therefore of repair bills, and that they cause the engineer a whole heap of trouble.

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